Mount Polley Mining Corporation

IMPERIAL METALS CORPORATION

2013 Environmental and Reclamation Report

Submitted to:

Ministry of Energy and Mines
(*Mines Act* Permit M-200)

And

Ministry of Environment

Prepared by:

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ABBREVIATIONS

ABA	acid-base accounting
ABR	Anaerobic Biological Reactor
ARD	acid rock drainage
BCWQG	BC water quality guideline
DO	dissolved oxygen
g/t	grams per tonne
ha	hectare(s)
km	kilometer(s)
LCRS	leachate concentrate recycle system
m	metre(s)
masl	metres above sea level
MDL	method detection limit
MEM	Ministry of Mines
MESCP	Main Embankment Seepage Collection Pond
mg/L	milligrams per litre
ML	metal leaching
mm	millimetre
MOE	Ministry of Environment
MPMC	Mount Polley Mining Corporation
Mt	million tonnes
MTD	Main Toe Drain
NAG	non-acid generating
NBD	North Bell Dump
NEZ	Northeast Zone
NPR	neutralizing potential ratio
ORP	oxygen-reduction potential
PAG	potentially acid generating
PESCP	Perimeter Embankment Seepage Collection Pond
POC	parameter of concern
QA/QC	quality assurance/quality control
RDS	rock disposal site
RPD	relative percent difference
SCIB	Soda Creek Indian Band
SERDS	Southeast Rock Disposal Site
SEZ	Southeast Zone
SPH	stems per hectare
STD	South Toe Drain
SWL	static water level
SWE	snow water equivalent
t	tonne(s)
tpd	tonnes per day
TSF	Tailings Storage Facility
TSS	total suspended solids
WWTP	waste water treatment plant
WLIB	Williams Lake Indian Band

1. INTRODUCTION

1.1. Purpose of Report

Mount Polley Mining Corporation (MPMC) is required to submit two annual reports; one to the Ministry of Environment (MOE), and a second to the Ministry of Mines (MEM). Beginning with the reporting year 2000 and continuing through 2013, these two reports have been combined into one for submission to both ministries.

The Annual Reclamation Report for MEM, as required by permit M-200, requires a summary and description of the past years mining and reclamation program including:

- Areas disturbed and associated disposal locations and stockpile descriptions.
- Completed site reclamation, reclamation research, and reclamation plans for the next 5 years.
- ARD/ML prediction data, and prevention and control plans.
- Drainage monitoring programs including flows and water quality.
- Geological characterization and material characterization test work.
- Reclamation liability cost estimates.

Under MOE Permit 11678, the annual report must include:

- All water quality monitoring results required under the Permit.
- An evaluation of the impacts of the mining operation on the receiving environment from the previous year.
- A summary of any non-compliance with the permit and other incidents that may have led to impacts on the receiving environment.
- An update to the water balance and water management plan.
- A review and update of the assessment of ARD potential and water quality impacts from mine waste management.
- A comparison of monitoring data with water quality guidelines, predictions, and targets.
- An update on the progress of reclamation and any updates to the reclamation plan.
- The results of any biological monitoring that may have been done.

The purpose of this document is to allow the MOE to: identify whether spills or incidents have been dealt with appropriately; evaluate permit compliance; identify environmental effects; verify predictions of effects; and identify whether the permit adequately protects the environment or if changes are required.

1.2. Project Description and Update

Imperial Metals Corporation is the sole owner/operator of Mount Polley Mine, an open pit copper/gold mine producing an average of 20,000 tonnes per day (tpd). The mine is located eight kilometres southwest of Likely and 100 km (by road) northeast of Williams Lake, British Columbia (Figure 1.1 Mount Polley Mine property location). The mine site is located on a ridge between Polley Lake and Bootjack Lake, both of which are situated within the Quesnel River watershed. The Mount Polley property covers 18,405 hectares (ha), which consist of seven mining leases totaling 2,006.75 ha, and 41 mineral claims encompassing 16,314.69 ha. Mount Polley concentrates are trucked to facilities at the Port of Vancouver, and shipped to overseas smelters or transported by rail to smelters in North America.

Clearing of the site and construction of the entire facility began in 1995, with the mill being commissioned in June 1997. In May of 1997 the mine received MOE Permit 11678, issued under the provisions of the provincial *Environmental Management Act*. The permit authorizes the discharge of concentrator tailings from milling ore or contaminated soil, mill site runoff, rock disposal site (RDS) runoff, open pit water, and septic tank effluent to a tailings impoundment. Approval of the Mount Polley Mine Reclamation and Closure Plan by the MEM resulted in the issuance of Permit M-200 under the *Mines Act* in July of 1997. The first full year of mining and milling at Mount Polley took place in 1998. The mine suspended operations in October 2001 due to low metal prices, then reopened in December 2004, with mill production commencing again in March of 2005. MOE Permit 11678 was amended in May 2005 to allow the discharge of effluent from the Main Embankment Seepage Collection Pond (MESCP). There have been no discharges from this location since 2005. In November 2012, the MOE approved an amendment of this permit to allow effluent discharge into Hazeltine Creek (projected to begin in spring 2013). Discharge from the MESCP is no longer permitted.

Current identified ore reserves indicate a projected mine life into the year 2025; however, the permitted mine life ends in 2016. An M-200 permit amendment was granted by MEM in July 2013 to construct a South Haul Road joining the Springer Pit and TSF, to establish a high grade ore stockpile adjacent to the existing Waste Haul Road, and to expand the Temporary PAG (potentially acid generating) Stockpile. These are all projects that require completion in order to facilitate the planned mine life extension, for which it is planned that a permit amendment application will be submitted in spring 2014. Given this anticipated extended mine life, reclamation and closure planning in this document assumes that the mine will not close in 2016.

The current permitted 2016 mine plan will involve the creation of seven pits: the Boundary Zone Pit, the Wight Pit, the Pond Zone Pit, the Southeast Zone (SEZ) Pit, the Cariboo Pit, the Springer Pit, the Bell Pit, and the C2 Pit. As of 2013, the Bell Pit, SEZ Pit, and Pond Zone Pit have been back-filled with waste rock. The Boundary Zone underground mining project continued in 2013. Active project infrastructure consists of the mill site, one active open pit (the Springer Pit), two active RDSs (the Southeast Rock Disposal Site (SERDS) and the Temporary PAG Stockpile), and a Tailings Storage Facility (TSF). Additional authorized works include the tailings discharge line, septic tank, open pits, drainage collection systems, and sediment/seepage control ponds, and tailings supernatant recycle system.

Significant changes that occurred over 2013 include:

- Expansion of the SERDS (SEZ Pit filled in).
- Expansion of the Temporary PAG Stockpile.
- Expansion of the Springer Cariboo Pits.
- Mining of the WX Zone Pit.
- Initiation the South Haul Road construction, including installation of a culvert in Bootjack Creek.
- Ongoing biosolids reclamation on the North Bell Dump (NBD).
- Construction of the West Ditch Sump (collecting water from upper Mine Drainage Creek).
- Construction of the West Ditch between Bootjack Lake and the mine site.
- Raising of the TSF to 967.1 masl.
- Completion and commissioning of the Hazeltine Creek discharge system.

Refer to Figure 1.2 for a detailed mine site map of all mine facilities.

1.2.1. *Permitting Forecast*

A number of permit amendment applications are planned for 2014, moving forward with mine life extension, reclamation research, and revised water management strategies. Refer to Table 1.1 for a summary of planned applications and projected timelines.

Table 1.1 2014 planned permit amendment applications

Permit	Amendment Request	Projected Application Date
15968 (MOE)	1. New biosolids stockpile. 2. 10% increase in biosolids application rate.	January 2014
11678 (MOE)	Water treatment and discharge into Polley Lake.	April 2014
M-200 (MEM)	1. Updated Springer and Cariboo Pit designs. 2. Updated SERDS Design.	May 2014
M-200 (MEM)	Mid-range TSF design proposed to align with Short-term Water Management Strategy.	May 2014

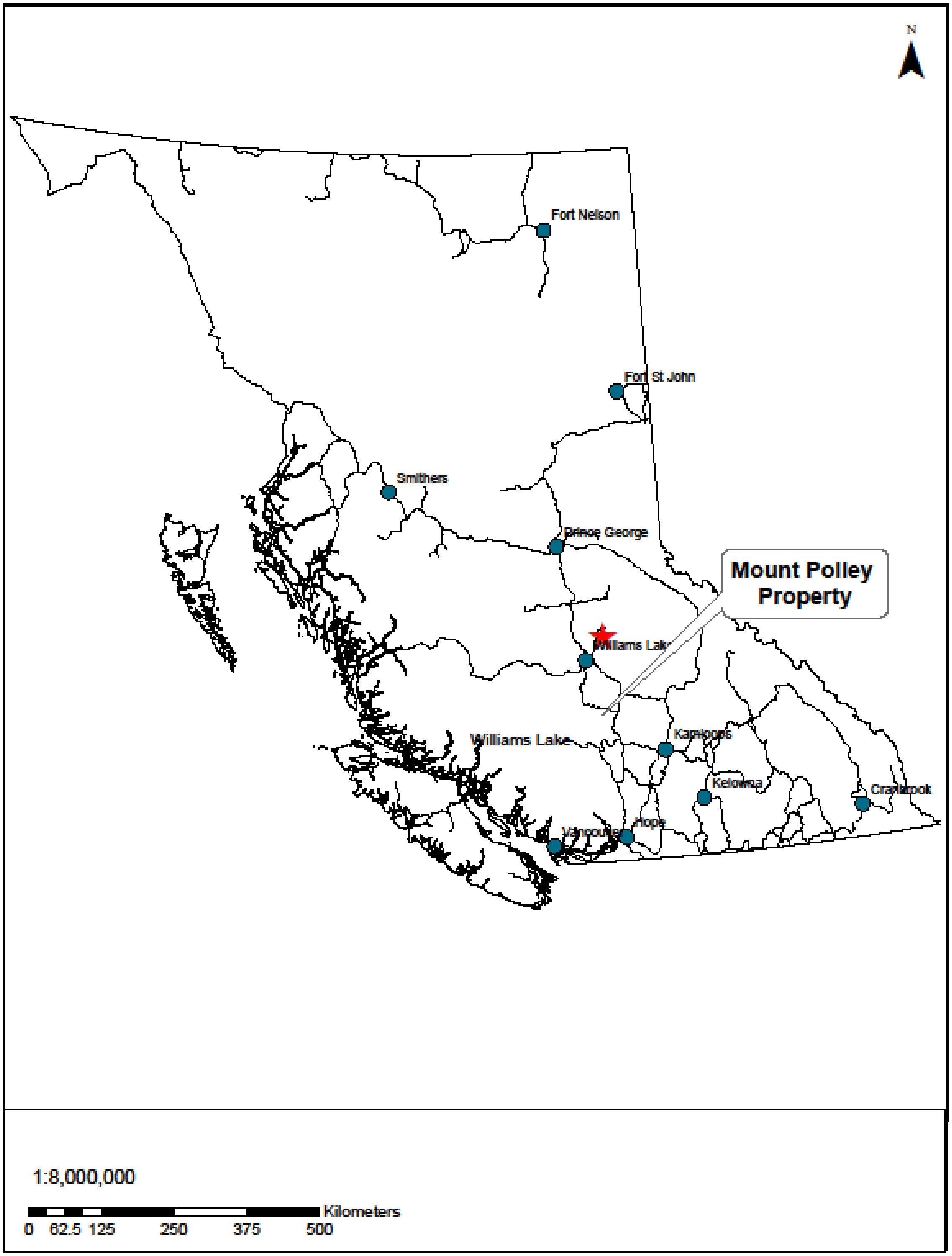

Figure 1.1 Mount Polley Mine property location

1.3. Reclamation Objectives

In accordance with the *BC Mines Act* and the *Health, Safety and Reclamation Code for Mines in British Columbia*, the primary objective of the Reclamation Plan is to:

> "*return all mine-disturbed areas to an equivalent level of capability to that which existed prior to mining on an average property basis, unless the owner, agent or manager can provide evidence which demonstrates to the satisfaction of the chief inspector the impracticality of doing so".*

In 1995 and 1996, a comprehensive environmental baseline-monitoring program, which expanded on previous studies (from 1989 and 1990), was designed and carried out in order to support mine planning, operations, and reclamation. The program included environmental baseline studies documenting the pre-development land use and conditions of the aquatic and terrestrial ecosystems. This provided the foundation upon which the operational and post–closure monitoring programs are based and reclamation activities are developed, such that the land may be returned to its original capability once mining has ceased. Environmental monitoring is ongoing, fulfilling both the requirements of the M–200 permit under MEM and Permit 11678 under MOE.

The site Reclamation and Closure Plan specifies the primary end land uses for the Mount Polley project area are wildlife habitat and forestry. Reclaimed areas will also be capable of supporting secondary end land uses including livestock grazing, hunting, guide-outfitting, trapping and outdoor recreation. Perpetuating, and, if possible, enhancing biodiversity are important considerations when planning for wildlife habitat as an end land use objective. The following objectives are implicit in achieving this primary goal:

- Long-term preservation of receiving water quality within and downstream of the receiving environment of the decommissioned operations.
- Long-term stability of engineered structures, including the RDSs, TSF and open pits, as well as all exposed erodible materials.
- Natural integration of disturbed lands into surrounding landscape and, to the greatest possible extent, restoration of the natural appearance of the area after mining ceases.
- Establishment of a self-sustaining vegetative cover, consistent with the end land uses of wildlife habitat, commercial forestry, and outdoor recreation.
- Removal and proper decommissioning of all secondary access roads, structures and equipment not required after the mine closes.

To achieve these objectives, reclamation planning must be flexible enough to allow for modifications to the mine plan, and to incorporate results from ongoing reclamation research programs into the plan. A Reclamation and Closure Plan Update was submitted to MEM in January 2012, and an updated Plan (incorporating the proposed mine expansion and MEM comments on the 2012 Plan) will be submitted with the mine life extension M-200 permit amendment application.

1.4. Environmental Monitoring Objectives

As per Permit 11678, environmental monitoring at Mount Polley consists of the following components:

- Drainage chemistry of surface, seepage and groundwater
- Aquatic biology
- Static water levels in groundwater wells
- Stream flows and water levels
- Meteorology (temperature, precipitation, snowpack, evaporation rates)
- Wildlife
- Biosolids quality and quantity (as per Permit 15968)
- Mineral-enriched soil shipments

The objective of this monitoring is to provide a comprehensive assessment of the environmental effects of mining activities at Mount Polley Mine on the receiving environment. This includes monitoring the quality and quantity of effluent sources and discharges, and the quality and quantity of surface and groundwater associated with the receiving environment. At such time that the mine discharges under the current permit, additional monitoring will be undertaken as required by Permit 11678 and the federal Metal Mining Effluent Regulations to ensure these objectives continues to be met. The area for monitoring encompasses the mine site and surrounding areas (both receiving environments and control sites).

2013 monitoring results are reported and interpreted in the subsequent sections of this report. A map of site monitoring locations is included as Figure 1.3.

1.5. Consultation

In 2012, MPMC executed Participation Agreements with both First Nations groups that have interest in the area: Xat'sull Cm'etem (Soda Creek/Deep Creek Band) and the T'exelc (Williams Lake Band). Through these respective Participation Agreements, Implementation Committees were formed in order to facilitate open dialogue between both Nations and MPMC for discussing environmental, social and economic matters related to mine development, operation, reclamation and closure (i.e. mine updates, permitting, environmental protection, reclamation, employment opportunities and potential joint ventures).

Meetings have taken place since March 16, 2012 with the Williams Lake Indian Band (WLIB) and since July 19, 2012 with the Soda Creek Indian Band (SCIB). Since October 18, 2012, Joint Implementation Committee meetings have been held with representatives from MPMC, the WLIB and the SCIB bi-monthly. These meetings provide a well-defined, constructive forum in which issues, reviews, and comments relating to the present and future operations of Mount Polley Mine may be discussed. This document will be provided in its current form to the SCIB and WLIB for review, and discussion regarding any comments or concerns will be facilitated through the Joint Implementation Committee.

Similar discussions take place at bi-annual Public Liaison Committee Meetings which are held by MPMC with community stakeholders, including representatives from conservation organizations, local, regional, and provincial government, business owners, the WLIB, the SCIB, and recreation groups. These programs reflect the initiative taken by MPMC to improve acceptance of operations in the region and local community; forming an integral part of the validation of a broader license to operate for Mount Polley Mine. This document will be available at the Williams Lake and Likely public library for review by interested parties.

2. WASTE STORAGE

2.1. Storage

In the course of its ongoing operations, Mount Polley utilizes a variety of hazardous chemicals, reagents, and other products. At any one time the volumes of materials in Table 2.1 could be expected to be on site.

In 2013, Mount Polly accepted approximately 2 244 tonnes of mineral-enriched soil from Vancouver Wharves the Langley site and approximately 1 361 tonnes of soil from HAZCO. All deliveries were stockpiled for use at the leach pad. After these materials are processed through the mill they report to the tailings pond. Generally, these materials are similar to mine waste material found at Mount Polley. Monthly composite tailings samples were taken when processing the Langley soil and all analytical results were below the lead level found in Table 1 of Schedule 4 *Leachate Quality Standards* of the Hazardous Waste Regulation.

Table 2.1 Chemicals and reagents stored at the Mount Polley Mine site

Materials	Total Stored (Kg)
PAX	17 000
Lime	100 000
Poly Clear Floc	672
Poly Froth Floc	15 550
NaHS	12 000
Methanol	12 000
Explosives	600 000

2.2. Waste Management

2.2.1. *Recycling*

MPMC recognizes the value in responsible waste management and recycling plays a large role in our waste management practices. Mount Polley continues to recycle used materials including waste oil, scrap steel, batteries, plastic pails, electronic waste, and beverage containers. In 2013 cardboard and paper recycling initiatives were undertaken. In addition, a lights, lamps, ballasts and fixtures recycling program was implemented.

In 2013, Mount Polley donated the funds generated by its beverage container recycling program to the Big Brothers and Big Sisters of Williams Lake.

Recycling and waste management awareness presentations are planned for Mount Polley employees in 2014 and are anticipated as being part of an annual training regime.

2.2.2. *Chemical, Reagent or Contaminated Waste Disposal*

In the course of its ongoing operations, Mount Polley utilizes potentially hazardous chemicals, reagents, and other products that are subject to a waste disposal management plan. In 2013 Sumas Environmental Services Ltd. was scheduled on a routine basis to remove and dispose of these waste products in an environmentally safe manner compliant with all relevant waste management legislation. Products removed include aerosol cans, contaminated gasoline or diesel, waste oil (in drums), waste oil filters, waste grease fuel or oil soaked rags, debris, and floor dry, and leachable liquid toxic waste such as glycol/anti-freeze mix. The waste oil tank is emptied and the oil removed from site by Load Em' Up Contracting.

3. INCIDENTS

3.1. Spills of Hydrocarbon or Dangerous Goods

All spills of hydrocarbons, coolant, and chemicals are reported to the environmental department. In 2013 there were two chemical spills, three coolant spills, and sixteen hydrocarbon spills reported. Of these spills, seven were considered reportable to Emergency Management BC as outlined in the Spill Reporting Legislation (refer to Table 3.1). All spills were cleaned up and the materials were removed from site in environmentally safe barrels by Sumas Environmental Services Ltd.

Table 3.1 Spills reported to Emergency Management BC

Date Reported	Amount Reported	Product Spilled	Equipment	DGR#
27-Jan-13	1500	Hydraulic Oil	1800 Loader	122930
15-Feb-13	40	Coolant	Unit #6716	123118
23-Feb-13	250	Hydraulic Oil	1800 Loader	123202
18-May-13	200	Hydraulic Oil	Haul Truck 32	130494
26-Jul-13	50	Hydraulic Oil	6312 loader	131296
29-Dec-13	2000	Hydraulic Oil	6532 HT	132926

3.2. Water Releases

In 2013 there were no releases of mine influenced water.

3.3. Other Reportable Incidents

On April 6, 2013 a release of till from a haul road to a creek and the environment was reported to Emergency Management BC. Details regarding the release and the mitigation are provided in Appendix A.

4. DATA QUALITY ASSURANCE/QUALITY CONTROL

4.1. Data Quality Assurance/Quality Control

The purpose of the data quality assurance/quality control (QA/QC) program is to verify the reliability of monitoring data through the implementation of procedures for controlling and monitoring the measurement and analysis process. The QA/QC program provides information for the evaluation of the analytical procedures, and for the monitoring of issues pertaining to possible contamination, both in the field and in the analytical laboratory. The QA/QC program is conducted at all stages of the sampling program: sample collection, transport, filtration, and analysis and for all sites including surface water quality sites, lakes, and groundwater wells. Appendix B includes the National Quality Manual Summary provided by ALS.

4.1.1. *Data Quality Objectives*

The Laboratory Data Quality Objectives provided to MPMC by ALS are included in Appendix B.

4.1.2. *Replicates and Travel Blanks*

The field quality assurance program at Mount Polley includes one semi-blind replicate for standard parameters, one semi-blind replicate for total metals, one semi-blind replicate for dissolved metals and a travel blank or field blank that is submitted with each month's sample shipment.

The semi-blind replicates are intended to evaluate the QA/QC surrounding the sampling methods. Replicates are prepared by collecting two full sample suites from one location, labeling one with the correct sampling location name (e.g. E4) and labeling the second sample suite with anonymous name (e.g. ED). When the results are reported back from the analytical laboratory all parameters from the replicate and the actual sample are screened to confirm likeness or potential of sampling error/contamination. The screening process also considers small-scale natural variations in water quality which may occur over the timescale of collection (~10 minutes). In particular, there is considerable potential for variations in water quality over short-time scales during periods of high sediment loads.

Travel blanks and field blanks, supplied by the analytical laboratory, are exposed to the same conditions and treatments as the water samples collected, and are intended to monitor contamination that may occur in the field. The difference between travel and field blanks is that the field blanks are all opened at one of the sample locations to expose them to the natural environment and travel blanks remain closed at all times.

When conducting lake water quality sampling, an equipment blank sample is taken with the Van Dorn bottle at the beginning of each sampling event.

4.2. Field Methodology

4.2.1. *Sample Collection*

All water sampling was done in accordance with the procedures described in the *British Columbia Field Sampling Manual: 2003 – For Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples* and the Mount Polley *Quality Assurance/Quality Control Manual* (MPMC, 2013).

4.2.2. *Field Meters*

Field meters are used to measure dissolved oxygen, conductivity, pH, temperature, NTU, and water flow.

The conductivity and pH meter used for field analysis of surface water and groundwater is a WTW pH/Conductivity 3430 handheld multimeter. As recommended in the manual, the pH sensor is calibrated prior to all permitted sampling events, and the conductivity sensor is calibrated monthly. The results of these calibrations are recorded in a binder kept in the environmental trailer. In situ turbidity is measured with a LaMotte 2020e turbidity meter. Samples are measured against standard blanks, and the machine is calibrated regularly, with results recorded in the calibration binder.

Previously, MPMC staff used a portable flow monitoring device (Swoffer Model 3000) to measure creek discharge rates. In 2011, MPMC purchased a Sontek FlowTracker Acoustic Doppler Velocimeter. The user measures flow rates across a creek or ditch cross section using the FlowTracker handheld device. The device then calculates the discharge rate based on these measurements and input parameters.

Spring lake profiles were completed using an YSI 6600 multi-meter borrowed from the MOE Williams Lake office. June profiles data was collected using the YSI Professional Plus multi-meter instrument with a 30 m cable, purchased in 2011 by MPMC; however, the pH sensor was not working and surface pH data was measured with the WTW handheld meter. August profiles were completed by Cariboo Envirotech Ltd. (external consultant) using a YSI 600QS Multi-meter with a 30 m cable, rented form Hoskin Scientific in Burnaby, BC. Ideally the MPMC YSI Pro Plus would be used for all profile samples; however, due to equipment problems this was not possible in 2013. In addition, because of the 30 m cable, profiles for sample locations in Polley Lake that are greater than 32 m deep cannot be completed to within two metres of the lake bottom.

Field secchi disk monitoring is also completed in the lakes. In order to ensure the most accurate secchi disk readings are recorded, whenever possible secchi disk readings are done by the same technician throughout the season with a QA/QC check done annually by a more permanent staff member to evaluate consistency of the readings compared to other years.

4.2.3. ***Field Replicates***

Semi-blind field replicates were compared for the purpose of evaluating the precision of the methods used (i.e. combined precision of field methods, lab methods and the environmental variability between the side-by-side samples). A relative percent difference (RPD) of ±20% was used to identify significant differences between the replicate and sample, where the RPD (as %) can be defined as:

RPD (%) = (Value 1 – Value 2)/mean X 100

There were 10 field replicate samples collected in 2013 (Table 4.1). For total metal analyses, RPDs of >20% were observed only for Al on two occasions. (Table B.1, Appendix B). Some degree of environmental variability can be expected in replicate samples for parameters influenced by total suspended solids (TSS).

For dissolved metals analyses, there was one RPD results >20% observed for Al in June. It should be noted that fewer samples are collected for dissolved metals analysis than in previous years. (Table B.2, Appendix B).

For general parameters (Ammonia, Nitrate, Nitrite, Sulphate, and TSS), RPD results of >20% were observed three times (Table B.3, Appendix B).

Table 4.1 2013 field replicate sample locations

Date	Location	Name
3-Jan-13	W7	WG
6-Feb-13	E4	ED
4-Apr-13	E5	EE
1-May-13	W8z	WHz
6-Jun-13	E13	EM
12-Jun-13	Gw96-1a	GW96-aa
8-Aug-13	W4	WD
21-Aug-13	B2-S	B2-S Duplicate
3-Oct-13	JCP	JCP-Duplicate
5-Nov-13	STD	STD-Duplicate

4.2.4. ***Travel and Field Blanks***

Travel or field blanks are submitted to the lab with most monthly sample sets for total metals and general parameter analysis. In 2013 four (4) field blanks and nine (9) travel blanks were submitted. All results were below detection limits as expected.

Table 4.3 2013 Travel and field blank sample dates

Date Sampled	Type of Blank
6-Feb-13	Field
14-Mar-13	Travel
4-Apr-13	Field
1-May-13	Travel
13-May-13	Travel
6-Jun-13	Field
17-Jun-13	Trip
8-Aug-13	Field
5-Sep-13	Travel
3-Oct-13	Travel
7-Nov-13	Travel
18-Nov-13	Travel
17-Dec-13	Travel

5. Surface and Groundwater Monitoring

5.1. Surface Water Monitoring

Surface water sampling and analysis is conducted in accordance with sub-section 3.1 of the Mount Polley Permit 11678. The approved surface and groundwater monitoring plan for 2013 is provided in Appendix C of this report. Field pH, temperature and conductivity were measured concurrently with surface water sampling using a WTW Multimeter and recorded in a field book. The sampling program included monthly sampling at eight sites (E1, E4, E5 (East and West MTD), W3a, W4, W5, W7, W8 and, quarterly sampling at five more sites (E1, E7, W1, W8z, and W12), bi-annual sampling at two sites (W10 and W11), and intensive weekly TSS and turbidity sampling for 5 weeks at four sites (W4, W5, W7 and W8) during spring freshet and autumn low flows. Table 5.1 outlines the number of sampling events at each site in 2013. Samples were submitted to ALS Laboratory Group for analysis of: physical parameters (turbidity, total suspended solids, total dissolved solids, and hardness); anions and nutrients (alkalinity, sulfate, total nitrogen, nitrate plus nitrite, ammonia and ortho-phosphorus); total metals; and dissolved metals.

Table 5.1 Sampling events in 2013 at surface water quality sites

Site	Permit Required Sampling	Actual Sampling Events
E1	4	5
E4	12	12
E5	12	7
East MTD	5	10
West MTD	5	6
E7	4	10
E13	12	12
W1	4	4
W3a	12	19
W4	12	12
W5	12	12
W7*	12	18
W8	12	12
W8z	4	4
W10	2	3
W11	2	4
W12	4	4
HD-1	6	8
HD-1us	6	6

Thirteen parameters of concern were identified in the Chemical Characterization of the Proposed Effluent for Discharge to Hazeltine Creek (Knight Piesold, 2009) based on site geochemistry and historical characteristics, as well as existing and projected waste and water management practices. To monitor changes in the effluent surface water quality, in the subsequent sections, these thirteen key parameters of concern (POCs) were examined for each water quality site over time:

- **Physical Parameters**: Hardness, Total Suspended Solids
- **Anions**: Chloride, Sulphate
- **Nutrients**: Nitrate, Total phosphorus
- **Metals**: Dissolved Aluminum, Total Cadmium, Total Copper, Total Molybdenum, Total and Dissolved Iron, Total Selenium

Results for these POC concentrations were compared with current guidelines and regulations, and historical water quality trends. The data for all surface water quality sites are presented in tables and in figures in Appendix D. Note that results below method detection limit (MDL) are represented as 0.5*MDL in statistical calculations and graphs.

5.1.1. ***Site E1 – Tailings Supernatant***

Water quality at this site was sampled 5 times in 2013.

Notable observations in POC results:

TSS: Due to the continuous deposition of tailings into the pond, TSS is slightly elevated at this site. In 2013 the maximum TSS value was 54.9 mg/L and the mean was 18.6 mg/L.

Nitrate + Nitrite: A slight increase has been occurring since deposition of tailings commenced. The mean value in 2013 was 7.23 mg/L.

Total Selenium: Total and dissolved selenium levels increased slightly in 2012 and 2013. The mean value for total selenium in 2013 was 0.029 mg/L.

Mercury: Total and dissolved mercury levels remain below detection limits in 2013.

There were no other observed changes at E1 in 2013.

5.1.2. *Site E4 – Main Embankment Seepage Collection Pond*

Previously this site was permitted as a discharge location however with the issuance of the amended Permit 11678 this site is now considered a seep monitoring location and the information will be used for long term water chemistry monitoring.

Water quality at this site was sampled twelve times in 2013.

Notable observations in POC results:

Mercury: Total and dissolved mercury levels remain below detection limits in 2013.

Total Molybdenum: An increasing trend starting in 2005 continued through 2013 with a maximum total molybdenum result of 0.216 mg/L and an annual mean of 0.192 mg/L.

Total Selenium: An increase started late in 2010 and continued throughout 2013. The maximum value for total selenium was 0.0198 mg/L and the annual mean was 0.015 mg/L.

There were no changes observed for TSS, chloride, hardness, nitrate, total phosphorus, sulphate, aluminum, cadmium, copper, and iron.

5.1.3. *Site E5 – Main Embankment Drain Composite Plus East and West Main Toe Drains*

Site E5 was sampled seven times, and the East and West MTD's were sampled six times in 2013. In July a new toe drain monitoring structure was established allowing access to individual drains. E5 and the newly permitted East and West Main Toe Drains (MTD's) are considered discharge locations as they are the source of dam filtered water for the Hazeltine Discharge system.

Notable observations in POC results:

Hardness: E5 reported an average of 424.7 mg/L, East MTD was 403.5 mg/L and West MTD was 360.5 mg/L.

Chloride: This parameter has only been reported since early 2009 and generally fluctuates between 20 and 28 mg/L. E5 reported a mean of 22.3 mg/L, East MTD was 26.7 mg/L and West MTD was 26.37 mg/L.

Sulphate: E5 reported an annual mean of 472.75 mg/L, East MTD mean was 503.8, and West MTD mean was 461.67 mg/L.

Nitrate: Levels at E5 were slightly higher than at the individual toe drains. E5 annual mean was 2.63 mg/L, the mean at the East MTD was 1.38 mg/L, and at the West MTD the mean was 1.39 mg/L.

Total Cadmium: All cadmium results in 2013 at these sites were below MDL.

Total Copper: E5 reported an annual mean of 0.0089 mg/L, East MTD mean was 0.0051 mg/L, and the mean at the West MTD was 0.003 mg/L.

Total Molybdenum: E5 reported an annual mean of 0.177 mg/L, East MTD was 0.206 mg/L, and the West MTD was 0.198 mg/L.

Total Selenium: Levels at E5 were slightly higher than at the MTD's. The annual mean at E5 was 0.01 mg/L, at East MTD the mean was 0.0057 mg/L and 0.0052 mg/L at the West MTD.

With the exception of a reading in April (15 mg/L) at E5 all TSS results were at or below MDL. There were no changes observed in dissolved aluminum and results remain well below the BC Water Quality Guidelines (BCWQG).

Toxicity Testing: 96-hour LC50 toxicity (RBT) and 48-hr LC50 *Daphnia magna* analysis was conducted in May (not required by permit) by Nautilus Environmental. All toxicity results were non-lethal (i.e. no mortality observed in any test results).

5.1.4. ***Site E7 – Perimeter Embankment Seepage Collection Pond***

In 2006 this site was removed from the permit and sampling was no longer a conducted on a regular schedule until 2013 when the site once again became permitted. This site was sampled ten times in 2013 however five of these samples were collected in the month of December. In order to consider seasonal variability only one sample from December and five from the remained of the year were used for the following calculations.

Notable observations in POC results:

Hardness: There was no change observed at this site with an annual mean of 707 mg/L and a maximum of 852 mg/L.

Chloride: The maximum recorded value in 2013 was 13.5 mg/L and the annual mean was 8.03 mg/L.

Sulphate: A slight increase in sulphate levels were observed in 2013 with an annual mean of 615.33 mg/L (508.2 mg/L in 2012) and a maximum of 761 mg/L.

Nitrate: No change observed in 2013 with an average of 8.56 mg/L and a maximum of 10.8 mg/L.

Total Selenium: The annual mean for 2013 was 0.028 mg/L and the maximum was 0.052 mg/L.

TSS: Regular construction work and movement of pumps in 2013 create some sediment disturbance in this pond. The annual mean was 6.67 mg/L and the maximum was 12.3 mg/L.

There were no observed trends in aluminum, copper, iron, molybdenum, or phosphorus, in 2013.

5.1.5. ***Site E13 – Northwest Sump***

This sump was constructed in 2012 to collect the seepage and runoff from around the temporary PAG stockpile. Water chemistry is monitored at this site for long term water management planning. In 2013 there were twelve samples collected at this site.

Notable observations in POC results:

Hardness: The annual mean was 448.83 mg/L and the maximum was 684 mg/L.

Chloride: The maximum recorded value in 2013 was 9.86 mg/L and the annual mean was 17.6 mg/L.

Sulphate: The annual mean of 261.65 mg/L a maximum of 451 mg/L.

Nitrate: The annual mean was 13.78 mg/L and the maximum was 24.5 mg/L. Elevated nitrates are expected below a new rock disposal location.

Total Selenium: The annual mean for 2013 was 0.051 mg/L and the maximum was 0.11 mg/L.

Total Molybdenum: The annual mean was 0.026 mg/L and the maximum was 0.036 mg/L.

Total Copper: The annual mean was 0.022 mg/L and the maximum was 0.046 mg/L.

5.1.6. *HD-1 Hazeltine Discharge System*

Details of the operation of the entire Hazeltine discharge system are included in section 6 of this report. HD-1 was sampled 8 times in 2013. The first sample was collected on September 19th, prior to discharging to Hazeltine Creek. This sample was shipped to ALS laboratories for emergency analysis to ensure that the water quality was as expected. This site was then sampled 7 more times before the system was shut down on October 31, 2013 (including discharge and sampling on this date), and data from all 8 sampling events is considered below..

Notable observations in POC results:

Hardness: Mean 364.63 mg/L, maximum 377.0 mg/L

Chloride: Mean 26.69 mg/L, maximum 27.7 mg/L

Sulphate: Mean 457.63 mg/L, maximum 469 mg/L

Nitrate: Mean 1.49 mg/L, maximum 1.64 mg/L

Total Cadmium: All results were below MDL.

Total Copper: Mean 0.0027 mg/L, maximum 0.0043 mg/L

Total Molybdenum: Mean 0.20 mg/L, maximum 0.20 mg/L

Total Selenium: Mean 0.00493 mg/L. maximum 0.0052 mg/L

TSS: Most readings were below the MDL of 3.0. Two results were above MDL and unexpected. As discussed in section 5.1.12, these elevated TSS readings may have been a result of sampling or analysis error, but we are not able to confirm at this time.

Toxicity Testing: 96-hour LC50 toxicity (RBT) and 48-hr LC50 *Daphnia magna* and *Ceriodaphnia dubia (C. dubia)* analysis was conducted in October by Nautilus Environmental. These results were non-lethal (i.e. no mortality observed in any test results). Adverse effects were observed for the reproduction endpoint for the *C. dubia.* The *C.dubia* reproduction test is used to monitor changes and effects are expected in effluent water.

5.1.7. ***Supplemental Monitoring of Effluent Water Quality***

In addition to the permit requirements, Mount Polley does supplemental monitoring in order to fill in some data gaps. This includes:

Total and Dissolved Mercury at E1 and E4: All results below MDL.

Daphnia Magna toxicity at E1: All results "non-lethal".

Coliform and *Ecoli* at E1, E4: Some bacteria detected as expected in this environment.

Coliform and *Ecoli: at GW05-01, and 95-R-1: These wells are used for the domestic water system. No bacteria were detected.*

Mineral Oil and Grease samples collected at E4 and E1: all results below MDL.

5.1.8. ***Site W1 – Morehead Creek***

This site was sampled four times in 2013.

Notable observations in POC results:

Sulphate: An increasing trend in sulphate levels have been recorded at W1 since 2005. The 2013 maximum was 19.7 mg/L (15.5 mg/L in 2012) and the annual mean was 8.90 mg/L (7.21 mg/L in 2012).

Nitrate + Nitrite: There were no significant changes in nitrate + nitrite levels in 2013. The maximum level was 0.0657 mg/L.

Chloride: A slight increase in chloride has been observed at this site since 2009. The maximum level recorded in 2013 was 6.3 mg/L and the mean was 2.99 mg/L.

There were no noted changes of hardness, TSS, phosphorus, aluminum, total cadmium, copper, iron, molybdenum, and selenium results in 2013. Most remain below detection levels.

5.1.9. *Site W3a – Mine Drainage Creek at Mouth*

This site was sampled nineteen times in 2013. Increases in sulphate, nitrate, selenium, aluminum, and molybdenum observed at this site in 2011 and 2012 triggered an intensive investigation to determine the source of the contaminants. Ultimately a plan was developed to construct a ditch along the entire west side of the property collecting most of the water that runs off or seeps from the mine roads. More details on the final construction of the ditch and sump at Mine Drainage Creek are included in Appendix E (As Built Report).

A sample taken on March 14th showed unusually high TSS and metals and it is likely this was a result of a sampling error. These results from March 14th have been left out of this discussion however anions and nutrients have been included.

Notable observations in POC at W3a include:

Hardness: A slight increase was observed in 2013, with a maximum of 229mg/L (2012 saw 220 mg/L) and an annual mean of 193.06 mg/L (2012 saw 197 mg/L).

Chloride: A slight decrease was observed in 2013, with a maximum of 17 mg/L and annual mean of 11.82 mg/L.

Sulphate: First evidence of increase was observed in 2011 with a maximum of 54.1 mg/L and an annual mean of 39.35 mg/L. In 2013 the maximum reading for sulphate was 135 mg/L in June and the annual mean was 109.5.

Nitrate and Nitrite: An increasing trend continued here in 2013 with an annual mean of 1.70 mg/L, up from 1.11 mg/L in 2012. The maximum value for 2013 was 3.73 mg/L up from 1.96 mg/L in 2012.

Total Iron: April 8th sample saw iron levels of 1.45 mg/L, exceeding the BCWQG.

Total Molybdenum: An increasing trend continued at this site in 2013. The mean annual value was 0.0095 mg/L and the maximum was 0.0172 mg/L.

Selenium: A noted increase was observed in 2012 and 2013. The maximum in 2013 was 0.012 mg/L and the mean annual value was 0.004235 mg/L (exceeding the BCWQG maximum).

There were no changes observed in TSS, phosphorus, dissolved aluminum, total cadmium, and copper, values in 2013.

5.1.10. *Site W4 – North Dump Creek*

This site was sampled 15 times in 2013 for full metals suites and seven times for NTU and TSS only. (once per month, and for five consecutive weeks in spring and fall). .

Notable observations in POC results:

Hardness: A decrease has been observed since 2009. 2013 maximum was 179 mg/L a marked decrease from the 2012 maximum of 227 mg/L and the 2013 annual mean was 143.4 mg/L.

TSS: Generally below MDL with the exception of 5 samples most of which were taken during spring freshet. The maximum TSS recorded was 6.6 mg/L.

Chloride: In 2013 a decrease was observed from slightly elevated levels in 2012. The annual mean in 2013 was 0.502 (2012 was 0.59) mg/L. Seven results were below MDL of 0.50 mg/L.

Sulphate: A slight decrease in sulphate levels was observed at W4 in 2013. The maximum was 41.4 mg/L (significantly lower than the 2012 maximum of 112 mg/L) and the annual mean was 34.22 mg/L.

Nitrate and Nitrite: Similar to sulphate, a slight decrease was observed in 2013. The maximum was 0.212 mg/L (significantly lower than the 2012 maximum of 5.27 mg/L) and the annual mean was 0.105 mg/L.

Total Selenium: There was a slight decrease observed through 2013. The maximum value recorded for 2013 was 0.00206 mg/L which exceeds the BC Water Quality Guidelines. The annual mean was 0.00123mg/L. Three samples taken February 7, 19, and March 14 exceeded the BCWQG.

There were no changes observed in TSS, phosphorus, total cadmium, copper, iron, molybdenum values in 2013.

Background for W4:

Mount Polley staff has observed an increase in levels of nitrate, sulphate and selenium at this monitoring location in past years, and have taken significant steps to remediate the situation. A coffer dam and pipeline to collect drainage from the North Bell Dump was constructed in September of 2009 to divert flow to the Long Ditch (which reports to the TSF).

In June of 2010 there was a breach of the coffer dam when a valve in the pipeline was closed and the sulphate, nitrate, copper, and aluminum results reflect this event. This was remediated immediately by opening the valve and removing the handle, and subsequent sulphate values were much lower.

On May 17, 2012 during a routine environmental inspection it was observed that the water levels in the Coffer dam above W4 were high and that a breach had occurred. Steps were taken to remediate the situation.

In 2013 it appears that improvements to the Coffer dam were successful in protecting the creek form influence from the North Dump seepage.

5.1.11. ***Site W5 – Bootjack Creek***

This site was sampled 12 times for full metals suite and 9 times for TSS and ntu only. Notable observations in POC results:

Sulphate: In 2013 levels increased from 2012 to a maximum of 36.4 mg/L and an annual mean of 9.73 mg/L. A noticeable increase was observed in the last quarter of the year.

Nitrate and Nitrite: Similar to sulphate, these levels saw a slight increase in the last quarter of the year. The annual mean was 0.215 mg/L and the maximum was 1.38 mg/L.

Total Selenium: With the exception of the December 3rd sample all samples were below MDL (0.00050) in 2013.

There was a slight increase in chloride, and total phosphorus levels in 2013 and one high TSS reading was recorded in September. The field notes for the September sample indicate that the flow in the creek was very low which may have resulted in some of the bottom sediments being picked up in the sample.

There were no noted changes in hardness, total molybdenum, total cadmium, total copper, and total iron levels in 2013.

5.1.12. *Site W7 – Upper Hazeltine Creek*

This site was monitored 18 times in 2013. Sampling was completed monthly and 6 times weekly during a discharge trial in September and October.

Notable observations in POC results:

TSS: With the exception of one outlier result of 197 mg/L on October 29, 2013 there was no change observed. Thirteen of the results were below MDL and a maximum of 6.3 mg/L was recorded during freshet in May. The elevated TSS reading collected in October cannot be explained. We have reviewed the field notes and discussed the result with the analytical lab but are unable to determine if the result is real, a sampling error or a lab error.

Sulphate: In 2013 the maximum recorded value during discharge was 40.4 mg/L and 32.4 mg/L during the non-discharge period in December. In 2013 the annual mean was 29.3 mg/L.

Dissolved Aluminum: In 2013 D-Al levels exceeded the BCWQG four (4) times. These results are common for this site as sampling from 1996 to present show several exceedences throughout the year.

Total Molybdenum: Prior to discharge no change was observed since 2011. During the discharge period there was a slight increase in levels with a maximum of 0.00445 mg/L, relative to pre-discharge concentrations with a maximum of 0.0023 mg/L, and the annual mean was 0.0025 mg/L (0.00197 mg/L in 2011). The 30 day average BCWQG for molybdenum is 1 mg/L. The 30-day Mean from Table 1 in Permit 11678 is 0.05 mg/L.

Total Selenium: No changes observed; eleven results were below MDL including all results during discharge period.

There were no noted changes in hardness, chloride, phosphorus, dissolved aluminum, total cadmium, copper, and iron values between 2009 and 2013.

Toxicity Testing: During the discharge from HD-1 a sample was collected and sent to Nautilus Environmental for *Ceriodaphnia dubia (C. dubia)* analysis. These results were non-lethal (i.e. no mortality observed in any test results).

5.1.13. *Site W8 – Northeast Edney Creek Tributary*

This site was sampled twelve times in 2013 for full metals suite and 9 times for NTU and TSS only as required by Permit 11678.

Notable observations in POC results:

Chloride: A slight increase in chloride has been occurring at this site since 2009. The maximum for 2013 was 7.62 mg/L up from 6.36 mg/L in 2012, and the annual mean in 2013 was 4.91mg/L, an increase from 3.52 mg/L in 2012. All results remain well below the 30 day average Provincial guideline of 150 mg/L.

Nitrate + Nitrite: There was a slight increase in nitrate + nitrite observed at this site since 2010 however the levels are well below the provincial guidelines. The maximum level recorded in 2013 was 0.637 mg/L and the annual mean was 0.158 mg/L.

There were no noted changes in TSS, hardness, aluminum, iron, sulphate, phosphorus, total cadmium, copper, molybdenum and selenium in 2013.

5.1.14. *Site W8z – Southwest Edney Creek Tributary*

This site was sampled 4 times in 2013, once per quarter.

It should be noted that this is a control site, as it is not downstream of any Mount Polley Mine component.

There were no changes in water quality observed at this location compared to past years.

5.1.15. *Site W10– Lower Hazeltine Creek*

Prior to this becoming a permitted site there were only a few samples collected here since 1995. This site was sampled three times in 2013. This site is a far-field site, selected for comparisons to the sites downstream from the mine disturbance.

Notable observations in POC results:

Sulphate: A maximum level of 14.5 mg/L was recorded in August 2013 and the minimum was 1.49 mg/L recorded in June (during freshet).

Nitrate: A maximum level of 0.026 mg/L was recorded in August 2013 and the minimum was 0.012 mg/L recorded in June (during freshet).

Total Molybdenum: A maximum level of 0.0020 mg/L was recorded in August 2013 and the minimum was 0.00049 mg/L recorded in June (during freshet).

Total Copper: A maximum level of 0.0028 mg/L was recorded in June 2013 and the minimum was below MDL in November.

Total cadmium and selenium results were all below MDL.

5.1.16. ***Site W11 – Lower Edney Creek U/S of Quesnel Lake***

This site was sampled four times in 2013. This site is a far-field site, selected for comparisons to the sites downstream from the mine disturbance.

Notable observations in POC results:

Sulphate: An increasing trend has been observed at this site from 2000 to 2013 with a maximum value in 2013 of 17.8 mg/L and an annual mean in 2013 of 15.175 mg/L (2012 saw 12.6 mg/L).

There were no other changes in water quality observed at this site in 2013.

5.1.17. ***Site W12 – 6K Creek at Road***

This site was sampled four times in 2013.

Notable observations in POC results:

Sulphate: An increasing trend has been observed at this site from 2000 to 2013 with a maximum value in 2013 of 29.2 mg/L and an annual mean in 2013 of 16.94 mg/L (2012 saw 12.4 mg/L).

There were no other significant changes in water quality observed at this monitoring location in 2013.

5.2. Groundwater Monitoring

5.2.1. ***Program Background***

In 1995, groundwater-monitoring wells (series 95) were installed in the vicinity of the open pits and the mill site. One of these wells (95R-5) still exists and remains part of the sampling program. In 1996, in order to monitor aquifers in both surficial deposits and bedrock, the MOE requested the establishment of additional monitoring wells downslope of the pit, rock disposal site and TSF. In conjunction with these ‘downslope’ wells, background wells were established upslope of any potential impacts by mining activities. This resulted in nine groundwater-monitoring wells being established in 1996 (series 96). Six of these sites are multi-level, consisting of “A” (deep) wells and “B” (shallow) wells, while the remaining three sites monitor a single depth. A commitment to install three additional multi-level monitoring locations along the southeast embankment of the TSF was made in 1996. These wells were subsequently installed in 2000. In 2005, GW05-01 was established to capture groundwater moving from Polley Lake towards the Wight Pit and pump it back into Polley Lake.

In 2011, to monitor potential impacts of newly disturbed areas, two additional multi-level monitoring sites were established below the temporary Potential Acid-Generating (PAG) Dump on Bootjack Road, and below the Southeast Rock Disposal Site (SERDS) on Polley Lake.

In 2012, MPMC retained AMEC to complete a site hydrogeological assessment. Based on AMEC’s recommendation, five pairs of monitoring wells were installed in 2012 and well 95R-4 was decommissioned. The full report was included in the *2012 Annual Environmental and Reclamation Report,* The following recommendations for moving forward were:

1. Conduct a study correlating changes in groundwater chemistry with the waste rock and tailings geochemistry data. Some sampling in the tailings would help define mechanisms there.
2. Continue to monitor 95-R5 for two more events but consider replacing this well with a nested pair.
3. Water quality results for the new wells GW12-4 and GW12-5 may indicate a need for expanded monitoring in this area.
4. A detailed water balance should be prepared to assess the groundwater volumes reporting to the pits. This will aid in calibrating a groundwater flow model that can be used for closure planning.

Another hydrological assessment will be completed in 2017 as required under section 3.8 of Permit 11678.

5.2.2. ***Monitoring Program***

Objectives of the groundwater-monitoring program include the following (Knight Piésold Ltd., 1996):

- To determine the direction and volume of groundwater flow from the mine site and other disturbed areas to receiving waters.

- To identify the locations of all surficial and deep groundwater aquifers underlying the mine site and their points of discharge to surface water.
- To establish background groundwater quality in aquifers prior to mine development.
- To calculate seepage and groundwater contamination dilution ratios in surface receiving waters in order to minimize impacts.

Figure 1.3 shows the locations of all monitoring wells, and Table 5.2 provides the depth, elevation and location information for each well, as well as the required monitoring frequency, 2013 sampling events, and years sampled. The following wells have been deactivated due to mine disturbances, or no longer have enough water to be sampled due to fluctuations in the water table, and were not included in the 2013 sampling program:

- 95R-4 (deactivated fall 2013 based on AMEC recommendation)
- GW96-5a (sampled spring 2013; deactivated fall 2013 due to TSF expansion)
- GW96-5b (insufficient flow as of spring 2007; deactivated fall 2013 due to TSF expansion)
- GW96-6 (deactivated fall 2006)
- GW96-8a/b (deactivated winter 2011-2012 due to Ore Switchback Road construction)
- GW96-9 (deactivated spring 2006)
- GW00-2b (insufficient flow as of spring 2011)

Table 5.2 Monitoring well depth, elevation, location, and sampling information

Well ID	MOE EMS #	Well Depth	Elevation	Northing	Easting	Monitoring Frequency	2013 Sampling Events	Years Sampled
95R-5	E229695	79.2	977.69	582 3790.66	59 3687.50	Bi-annually	2	1995 - 2013
GW96-1a	E229679	59.0	927.89	581 9939.06	59 5415.82	Annually	1	1998 - 2013
GW96-1b	E229680	38.72	927.81	581 9935.22	59 5416.16	Annually	1	1998 - 2013
GW96-2a	E229681	54.88	931.42	581 9449.92	59 6065.40	Bi-annually	2	1998 - 2013
GW96-2b	E229682	35.67	931.42	581 9447.08	59 6074.73	Bi-annually	2	1998 - 2013
GW96-3a	E229683	52.59	912.06	581 8308.97	59 5768.75	Annually	1	1998 - 2013
GW96-3b	E229684	19.97	912.06	581 8306.52	59 5765.16	Bi-annually	2	1998 - 2013
GW96-4a	E229685	24.7	940.56	581 8164.58	59 5147.94	Annually	1	1998 - 2013
GW96-4b	E229686	7.16	940.46	581 8162.87	59 5151.26	Annually	1	1996 - 2013
GW96-5a	E229687	19.82	973.55	581 9626.68	59 4330.34	Bi-annually	1	1998 - 2013
GW96-7	E229690	14.12	1021.32	582 1520.53	59 2983.23	Bi-annually	2	1998 - 2013
GW00-1a	E242385	21.03	939.18	5818476	594368.01	Bi-annually	2	2000 - 2013
GW00-1b	E242385	10.58	939.13	5818475.85	594371.26	Bi-annually	2	2000 - 2013
GW00-2a	E242387	21.55	943.4	5818337.53	594651.75	Bi-annually	2	2000 - 2013
GW00-2b	E242386	10.64	943.32	5818336.4	594657.58	Annually	0	2000 - 2010
GW00-3a	E242389	24.29	943.07	5818238.13	594896.38	Bi-annually	2	2000 - 2013
GW00-3b	E242388	13.66	943.22	5818237.65	594899.99	Annually	1	2000 - 2013
GW05-01	E258923			593027	5825267	Bi-annually	5	2005 - 2013
GW11-1a	E291219	15.85	1030	5823845	590766	Bi-annually	2	2011 - 2013
GW11-1b	E291211	8.23	1030	5823845	590766	Bi-annually	2	2011 - 2013
GW11-2a	E291212	29.4	938	5821020	594910	Bi-annually	2	2011 - 2013
GW11-2b	E291213	14.3	938	5821020	594910	Bi-annually	2	2011 - 2013
GW12-1a	E291969	99.6	991.6	5824612.57	590420.67	Bi-annually	2	2013
GW12-1b	E291970	24.4	991.4	5824617.37	590420.53	Bi-annually	2	2013
GW12-2a	E291971	100.6	1035.4	5823179.94	591154.53	Bi-annually	2	2013
GW12-2b	E291972	30.2	1035.4	5823176.64	591153.57	Bi-annually	2	2013
GW12-3a	E291973	99.7	1039.2	5822098.48	592147.96	Bi-annually	3	2013
GW12-3b	E291974	16.1	1039.1	5822101.88	592147.58	Bi-annually	2	2013
GW12-4a	E291976	100.6	989.9	5822894.27	594117.41	Bi-annually	2	2013
GW12-4b	E291977	36.3	990.1	5822890.94	594115.97	Bi-annually	2	2013
GW12-5a	E291978	100.4	965.3	5824582.25	593197.11	Bi-annually	2	2013
GW12-5b	E291979	12.7	966.2	5824568.66	593199.48	Bi-annually	2	2013

Groundwater sampling and analysis was conducted in accordance with the *2013 Annual Monitoring Plan* (Appendix C), which was reviewed by AMEC and approved by MOE. The calibration, sampling, filtering, preservation and shipping procedures outlined in the *Quality Assurance / Quality Control Manual* (MPMC, 2013) and the *British Columbia Field Sampling Manual: 2003 – For Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples* and the Mount Polley *Quality Assurance/Quality Control Manual* are followed in the monitoring program. In situ pH, temperature and conductivity were measured at the time of sampling using a WTW Multimeter. Refer to section 4.1 for additional information on Data Quality Assurance/Quality Control, and Field Methodology.

Prior to drawing water from each well for purging and/or sampling, the phreatic (static) water level is measured and recorded. Results are presented in section 9.3. Samples are collected and then submitted to ALS Laboratory Group for water chemistry analysis, including: physical parameters (alkalinity, turbidity, total suspended solids, and hardness); anions and nutrients (sulfate, ammonia (N), nitrate, nitrite, nitrogen and phosphorus); and dissolved metals.

To monitor changes in groundwater quality, in the subsequent sections, nine key parameters of concern (POCs) are examined for each well over time:

Physical Parameters: Hardness

Anions: Sulphate

Nutrients: Nitrate

Dissolved Metals: Aluminum, Arsenic, Cadmium, Copper, Molybdenum, Selenium,

These POCs were identified in the Chemical Characterization of the Proposed Effluent for Discharge to Hazeltine Creek (Knight Piésold, 2009) based on site geochemistry, concentrations relative to current guidelines and regulations, historical water quality trends, and existing and projected waste and water management practices.

No groundwater quality guidelines are included in Permit 11678, so to establish if changes in water quality at any well are cause for concern or intervention, POC results are compared with the BC MOE Contaminated Sites Regulation (CSR) drinking water standards (the most stringent guidelines).

Table 5.3 BC MOE Contaminated Sites Regulation Schedule 6: Selected Water Standards

Parameter	Drinking Water (mg/L)
Dissolved aluminum	9.5
Total ammonia	no standard
Dissolved antimony	0.006
Dissolved arsenic	0.01
Dissolved barium	1
Dissolved beryllium	no standard
Dissolved boron	5
Dissolved cadmium	0.005
Dissolved chromium	0.05
Dissolved cobalt	no standard
Dissolved copper	1
Dissolved fluoride	1.5
Dissolved iron	6.5
Dissolved lead	0.01
Dissolved magnesium	100
Dissolved manganese	0.55
Dissolved mercury	0.001
Dissolved molybdenum	0.25
Dissolved nickel	
Nitrate N	10
Nitrite N	3.2
Dissolved selenium	0.01
Dissolved silver	no standard
Sulphate	500
Dissolved thallium	no standard
Dissolved titanium	no standard
Dissolved uranium	0.02
Dissolved zinc	5

Note: H means water hardness in mg/L CaCO3.

All groundwater results are presented in Appendix F of this report. This includes data in tabular form for each site, and graphs of the nine POCs (selenium was only graphed when results were above MDL). Note that results below method detection limit (MDL) are represented as 0.5*MDL in statistical calculations and graphs. Graphs were not included for wells installed in 2012, as they have only been sampled twice.

5.2.3. *Water Quality Results*

5.2.3.1. **95R-5 (Lower SERDS Well)**

95R-5 is located along the old Polley Lake Forest Service Road, northwest of the East RDS, and immediately east of the NEZ soil stockpile location. In reviewing the water quality data from this well, it should be noted that the phreatic level dropped significantly in 2008 (refer to Appendix M). With the exception of Arsenic, major improvements in water quality at this site were observed in 2013. Notable observations in POC results:

Hardness: Increased from approximately 190 mg/L in 2004 to a historic maximum of 782 mg/L in October 2010. Since 2010, hardness levels have gradually decreased, and in 2013 a significant decrease down to 276 mg/L in October was observed.

Sulphate: Increased from approximately 20 mg/L in 2004 to a historic maximum of 531 mg/L in October 2010. Since 2010, sulphate levels have gradually decreased, and in 2013 a significant decrease down to 127 mg/L in October was observed.

Arsenic: Increased from historic lows of approximately 0.0004 mg/L in 2009 through 2012 to a historic maximum of 0.0025 mg/L in October 2013.

Molybdenum: Increased from historic lows of approximately 0.015 mg/L in 2008 through 2012 to 0.0246 mg/L in October 2013. 2013 concentrations continue to be equal to or below baseline levels.

For the remaining POCs, 2013 values were similar to or below historic results, and any fluctuations or spikes in previous years have discontinued. All results were below the CSR guidelines.

5.2.3.2. **GW96-1a (TSF North Well – Deep)**

GW96-1a is located downslope of the PESCP. There were no significant changes in water quality at this well in 2013. For all of the POCs, 2013 values were similar to historic levels, and any fluctuations or spikes in previous years have stabilized. All results were below the CSR guidelines.

5.2.3.3. GW96-1b (TSF North Well – Shallow)

GW96-1b is located downslope of the PESCP. Notable observations in POC results:

Hardness: Has steadily increased since 1998 from 32.9 mg/L to 60.4 mg/L and 58.3 mg/L in May and October 2013, respectively.

For all remaining POCs, 2013 values were similar to or slightly below historic results, and any fluctuations or spikes in previous years have stabilized. All results were below the CSR guidelines.

5.2.3.4. GW96-2a (TSF East Well – Deep)

Groundwater monitoring well GW96-2a is located approximately 900 m southeast of the GW96-1 monitoring wells and was commissioned to monitor potential groundwater effects from the TSF on Hazeltine Creek. Notable observations in POC results:

Nitrate: Was elevated in 2012 from typical levels of 0.01 mg/L or lower, and spiked to a historic maximum of 0.0896 mg/L in June 2013 before decreasing to below MDL in October 2013.

For all remaining POCs, 2013 values were similar to or below historic results, and any fluctuations or spikes in previous years have stabilized. All results were below the CSR guidelines.

5.2.3.5. GW96-2b (TSF East Well – Shallow)

GW96-2b is located approximately 900 m Southeast from the GW96-1 monitoring wells and was commissioned to monitor potential groundwater effects from the Tailings Storage Facility on Hazeltine Creek. Notable observations in POC results:

Hardness: Has fluctuated significantly over time, but reached a historic maximum of 269 mg/L in October 2013 before decreasing to a more typical level of 243 mg/L in October.

Sulphate: Has steadily increased from approximately 6 mg/L in 2003 to a historic maximum of 82 mg/L in June 2013, followed by a decrease to 64.3 mg/L in October 2013.

Aluminum: Was typically below MDL and/or less than 0.001 mg/L from 2002 through 2013, but showed increases to 0.0043 mg/L, 0.0031 mg/L, and 0.0055 mg/L in May 2012, October 2012, and October 2013, respectively.

Molybdenum: Has shown increases above baseline (approximately 0.005 mg/L) since 2007, with spikes in September 2009 and October 2010. Levels continue to be elevated in 2013 at 0.00797 mg/L in June and 0.0094 mg/L in October.

Arsenic: Has remained slightly elevated above baseline (approximately 0.0013 mg/L) since 2008, with levels fluctuating between 0.0015 mg/L and 0.0018 mg/L.

For the remaining POCs, 2013 values were similar to or below historic results, and any spikes or fluctuations in previous years have stabilized. All results were below the CSR guidelines.

5.2.3.6. GW96-3a (TSF Southeast Well – Deep)

GW96-3a is located adjacent to MESCP. Throughout the monitoring period, many parameters have exhibited constant fluctuations including hardness, sulphate, aluminum, arsenic, cadmium, copper, and molybdenum. For POCs, 2013 values were within historic fluctuations, and any spikes in previous years have stabilized. Notably, nitrate levels decreased after being slightly elevated in 2012. All results were below the CSR guidelines.

5.2.3.7. GW96-3b (TSF Southeast Well – Shallow)

GW96-3b is located adjacent to the MESCP. Throughout the monitoring period, many parameters have exhibited constant fluctuations including sulphate, aluminum, arsenic, copper, and molybdenum. For POCs, 2013 values were within historic fluctuations, and any spikes in previous years have stabilized. Notably, nitrate levels decreased after being slightly elevated in 2012. All results were below the CSR guidelines.

5.2.3.8. GW96-4a (TSF Southwest Well – Deep)

GW96-4a is located downslope of the south and main embankments. Notable observations in POC results:

Hardness: In 2012 and 2013, increased to above previously observed fluctuations to a historic maximum of 119 mg/L in May 2013.

Nitrate: Starting in 2012 levels increased from baseline of approximately 0.01 mg/L to a historic maximum of 0.0957 mg/L in May 2013.

Sulphate: Levels were stable at approximately 2.5 mg/L from 2005 through 2011, then began increasing to a historic maximum of 19.9 mg/L in May 2013, although 1998 levels were approximately 12 mg/L.

For all other POCs, 2012 values were similar to or below historic results, and fluctuations or spikes in previous years have stabilized. All results were below the CSR guidelines.

5.2.3.9. GW96-4b (TSF Southwest Well – Shallow)

GW96-4b is located downslope of the South and Main Embankments. Notable observations in POC results:

Hardness: Has steadily increased from approximately 180 mg/L in 1996 through 1998 to a historic maximum of 44 g/L in May 2013.

Nitrate: Has increased from below MDL (0.005 mg/L) in May 2011 to greater than an average of 0.53 mg/L in 2012 and 2013.

Sulphate: Has increased from approximately 2 mg/L in 2010 to a historic maximum of 218 mg/L in May 2013.

For all other POCs, 2013 values were similar to historic results, and any fluctuations or spikes in previous years have stabilized. All results were below the CSR guidelines.

5.2.3.10. GW96-5a (Tailings Storage Facility Control Well – Deep)

GW96-5a is located at the upstream (north) of the TSF and is monitored as a control site. For all of the POCs, 2013 values were similar to or below historic results, and any fluctuations or spikes in previous years have stabilized. All results were below the CSR guidelines.

GW96-5a and GW96-5b were decommissioned with grout plugs in November 27, 2014 as the site was being lost due to expansion of the TSF.

5.2.3.11. GW96-7 (Southeast Sediment Pond Well)

GW96-7 is located downslope of the Mill Site, half way down the tailings access road (near the booster pump station). Notable observations in POC results:

Hardness: Was stable at approximately 145 mg/L through 2010, but spiked to 267 mg/L in May 2011, and has since decreased to 159 mg/L in October 2013.

Sulphate: Was stable at approximately 27 mg/L through 2010, but spiked to 158 mg/L in May 2011, and has since decreased to 36.2 mg/L in October 2013.

Molybdenum: Was stable at approximately 0.005 mg/L through 2010, but increased to 0.01 mg/L in May 2011, and has since decreased to 0.00583 mg/L in October 2013.

For the remaining POCs, 2013 values were similar to historic results, and any fluctuations or spikes in previous years have stabilized. All results were below the CSR guidelines.

5.2.3.12. GW00-1a (TSF Northwest Well – Deep)

GW00-1a is located across the Gavin Lake FSR, beside the TSF South Embankment. Notable observations in POC results:

Hardness: From the historic maximum of 53.6 mg/L in 2000, levels decreased through 2005, but have since increased from a historic minimum of 29 mg/L in 2005 to 36.1 mg/L in October 2013.

Sulphate: From the historic maximum of 335 mg/L in 2000, levels decreased through 2005, but have since increased from a historic minimum of 187 mg/L in 2005 to 281 mg/L in October 2013.

Molybdenum: From the historic maximum of 0.0271 mg/L in 2000, levels decreased through 2004, but have since increased from a historic minimum of 0.0165 mg/L in 2004 to 0.0257 mg/L and 0.0247 mg/L in June and October of 2013, respectively.

For the remaining POCs, 2013 values were similar to or below historic results, and any fluctuations or spikes in previous years have stabilized. All results were below the CSR guidelines.

5.2.3.13. GW00-1b (TSF Northwest Well – Shallow)

GW00-1b is located across the Gavin Lake FSR, beside the TSF South Embankment. Notable observations in POC results:

Hardness: Levels were stable at approximately 260 mg/L through 2008, but increased between 2008 and 2010, and have since fluctuated around 530 mg/L.

Nitrate: Has decreased from the spike of 17.1 mg/L in October 2011 to 2.71 mg/L in October 2013, but still remains above baseline levels of below MDL (0.005 mg/L).

Sulphate: Levels were stable at approximately 8 mg/L through 2007, but increased in 2008 and 2009, and have since fluctuated around 275 mg/L.

Cadmium: In 2007, levels spiked from approximately 0.00003 mg/L to a historic maximum of 0.000186 mg/L in 2008. Concentrations had been decreasing since 2008, but increased again in 2013 to 0.000137 mg/L in October 2013.

Molybdenum: Increased from 0.004 mg/L in 2007 to a historic maximum of 0.041 mg/L in May 2012, but have since decreased to 0.0287 mg/L and 0.0338 mg/L in May and October of 2013, respectively.

Selenium: Increased from below MDL in 2008 to a historic maximum of 0.029 mg/L in October 2011, but has subsequently decreased to 0.0007 mg/L in October 2013.

For all remaining POCs, 2013 values were similar to historic results, and any fluctuations or spikes in previous years have stabilized. All results were below the CSR guidelines.

5.2.3.14. GW00-2a (TSF West Well – Deep)

GW00-2a is located downstream of the TSF South Embankment. For all POCs, 2013 values were similar to historic results, and any fluctuations or spikes in previous years have stabilized. All results were below the CSR guidelines.

5.2.3.15. GW00-3a (TSF Southwest Well – Deep)

GW00-3a is located downstream of the TSF South Embankment. For all POCs, 2013 values were similar to historic results, and any fluctuations or spikes in previous years have stabilized. All results were below the CSR guidelines.

5.2.3.16. GW00-3b (TSF Southwest Well – Shallow)

GW00-3b is located downstream of the TSF South Embankment. This well was not sampled in 2012 due to a lack of water, but for all POCs, 2013 values were similar to historic results. All results were below the CSR guidelines.

5.2.3.17. GW05-01 (Wight Pit/Polley Lake Interface Well)

GW05-01 is located between the Wight Pit and Polley Lake. It was established in 2005 to capture groundwater moving from Polley Lake towards the Wight Pit and continuously pump it back to Polley Lake. In June of 2010, pumping was terminated making it impossible to sample; however, this now provides domestic water for the underground operations, and sampling from the tap commenced in June 2012. Notable observations in POC results:

Copper: Levels fluctuated around 0.001 mg/L until 2012 when an increase to the historic maximum of 0.0272 mg/L was observed in November. In 2013 results ranged from 0.00064 mg/L to 0.0133 mg/L.

Molybdenum: Fluctuated around 0.005 mg/L until 2009 when it began increasing, reaching a historic maximum of 0.008 mg/L in November 2013.

Selenium: Spiked from below MDL to a historic maximum of 0.00063 mg/L in June 2012, but has since decreased to approximately 0.0005 mg/L in 2013.

For all remaining POCs, 2013 values were similar to historic results. Many parameters have undergone significant fluctuations or spikes in previous years, but results have either stabilized or fall within the typical range of values. All results were below the CSR guidelines.

5.2.3.18. GW11-1a (Below Temporary PAG Stockpile on Bootjack Road - Deep)

GW11-1a is located below the Temporary PAG Stockpile on Bootjack Road to monitor potential impacts on Bootjack Lake. Notable observations in POC results:

Hardness: Levels ranged from 73.2 mg/L to 83.0 mg/L in 2011 and 2012. In 2013 an increase to 91.4 mg/L in October was observed.

Aluminum: Increased from approximately 0.003 mg/L in 2011 and 2013 to 0.0054 mg/L in October 2013.

For all remaining POCs, 2013 values were similar to or below 2011 and 2012 levels. All results were below the CSR Guidelines. Nitrate, copper, and selenium levels have been below MDL since sampling commenced in 2011.

5.2.3.19. GW11-1b (Below Temporary PAG Stockpile on Bootjack Road - Shallow)

GW11-1b is located below the Temporary PAG Stockpile on Bootjack Road to monitor potential impacts on Bootjack Lake. Notable observations in POC results:

Hardness: Has increased from approximately 140 mg/L in December 2011 and May 2012 to 219 mg/L in October 2013.

Nitrate: Was below MDL (0.005 mg/L) for all sample results until October 2013 when levels increased to 0.0076 mg/L.

Cadmium: After fluctuating around approximately 0.000015 mg/L, levels increased to 0.000053 mg/L in October 2013.

Copper: After fluctuating from below MDL (0.0005 mg/L) to 0.00083 mg/L, levels increased to 0.00135 mg/L in October 2013.

For all remaining POCs, results were similar to or below 2011 and 2012 levels. All results were below the CSR Guidelines.

5.2.3.20. GW11-2a (Below SERDS on Polley Lake Road - Deep)

GW11-2a is located below the SERDS on Polley Lake Road. Notable observations in POC results:

Copper: Has increased from 0.00131 mg/L in December 2011 to 0.0049 mg/L in June 2013, then decreased to 0.00213 mg/L in October 2013.

For all remaining POCs, results were similar or below 2011 and 2012 levels. All results were below the CSR Guidelines. It is also of note that typically the in situ pH is greater than 12, and the in situ conductivity is approximately 3000 µS/cm. This is likely because the well is located in a calcium deposit; dissolved calcium levels exceed 200 mg/L.

5.2.3.21. GW11-2b (Below SERDS on Polley Lake Road - Shallow)

GW11-2b is located below the SERDS on Polley Lake Road.

Aluminum: Decreased from approximately 0.05 mg/L in 2011 and 2012 to 0.0255 mg/L in October 2013.

Arsenic: Increased from 2011 and 2012 levels of approximately 0.005 mg/L to 0.0086 mg/L in June 2013, with the arsenic concentration returning to 0.00447 mg/L in October 2013.

For all remaining POCs, results were similar or below 2011 and 2012 levels. All results were below the CSR Guidelines, and cadmium, copper, and selenium were below MDL.

5.2.3.22. GW12-1a (NW of Temporary PAG Stockpile – Deep)

GW12-1a is located below the Temporary PAG Stockpile, just above the NW Sump, to monitor the expanding dump. The two sampling events in 2013 are insufficient to indicate trends; however, all results are below the CSR guidelines, all POCs except sulphate and arsenic decreased between June and October 2013, and nitrate levels were below MDL.

5.2.3.23. GW12-1b (NW of Temporary PAG Stockpile – Shallow)

GW12-1b is located below the Temporary PAG Stockpile, just above the NW Sump, to monitor the expanding dump. The two sampling events in 2013 are insufficient to indicate trends; however, all results are below the CSR guidelines, all POCs except arsenic decreased between June and October 2013, and aluminum levels were below MDL.

5.2.3.24. GW 12-2a (Springer Pit Well – Deep)

GW12-2a is located between the Springer Pit and Bootjack Lake, and was installed to replace the compromised well 95R-4. The two sampling events in 2013 are insufficient to indicate trends; however, all results are below the CSR guidelines, all POCs except cadmium and molybdenum decreased between June and October 2013, and copper levels were below MDL.

5.2.3.1. GW 12-2b (Springer Pit Well – Shallow)

GW12-2b is located between the Springer Pit and Bootjack Lake, and was installed to replace the compromised well 95R-4. The two sampling events in 2013 are insufficient to indicate trends; however, all results are below the CSR guidelines, all POCs except arsenic decreased between June and October 2013, and aluminum, cadmium, and copper levels were below MDL.

5.2.3.2. GW12-3a (Below Waste Haul Road – Deep)

GW12-3a is located below the Waste Haul Road and was installed to replace GW96-8a, which was lost due to construction of the Ore Switchback Haul Road, and to monitor potential impacts of the haul road on Mine Drainage Creek and Bootjack Lake. The three sampling events in 2013 are insufficient to indicate trends; however, all results are below the CSR guidelines, all POCs except hardness, nitrate, and arsenic decreased between June and October 2013, and copper levels were below MDL.

5.2.3.1. GW12-3b (Below Waste Haul Road – Shallow)

GW12-3b is located below the Waste Haul Road and was installed to replace GW96-8b, which was lost due to construction of the Ore Switchback Haul Road, and to monitor potential impacts of the haul road on Mine Drainage Creek and Bootjack Lake. The three sampling events in 2013 are insufficient to indicate trends; however, all results are below the CSR guidelines, all POCs except nitrate increased between June and October 2013, and aluminum and copper levels were below MDL.

5.2.3.2. **GW12-4a (Below NEZ Dump – Deep)**

GW12-4a is located below the NEZ Dump, above the Long Ditch, and was installed to improve monitoring of groundwater inflow into Polley Lake. The two sampling events in 2013 are insufficient to indicate trends; however, all results are below the CSR guidelines, and all POCs except hardness, sulphate, and arsenic decreased between June and October 2013.

5.2.3.1. **GW12-4b (Below NEZ Dump – Shallow)**

GW12-4b is located below the NEZ Dump, above the Long Ditch, and was installed to improve monitoring of groundwater inflow into Polley Lake. The two sampling events in 2013 are insufficient to indicate trends; however, all results are below the CSR guidelines, all POCs except hardness, nitrate, and molybdenum decreased between June and October 2013, and aluminum, copper, and selenium levels were below MDL.

5.2.3.2. **GW12-5a (Below Wight Pit Haul Road – Deep)**

GW12-5a is located below the Wight Pit Haul Road, and was installed to improve monitoring of groundwater inflow into Polley Lake. The two sampling events in 2013 are insufficient to indicate trends; however, all results are below the CSR guidelines, sulphate, aluminum, and cadmium decreased between June and October 2013, and nitrate, aluminum, copper, and selenium levels were below MDL.

5.2.3.1. **GW12-5b (Below Wight Pit Haul Road – Shallow)**

GW12-5b is located below the Wight Pit Haul Road, and was installed to improve monitoring of groundwater inflow into Polley Lake. The two sampling events in 2013 are insufficient to indicate trends; however, all results are below the CSR guidelines, all POCs except arsenic decreased between June and October 2013, and aluminum levels were below MDL.

6. HAZELTINE DISCHARGE SYSTEM AND MONITORING

Permit 11678 section 2.6 requires submission for approval of an annual discharge plan. The *2013 Annual Discharge* Plan is included in this report as Appendix G. The 2013 discharge plan estimated a discharge of 77, 472 m^3 from the Main Toe Drains to Hazeltine Creek commencing in May 2013. This volume was based on estimated toe drain flows, predicted Hazeltine Creek flows, and estimated water quality based on previous recorded values. Due to the late start of construction and the technical complication of the infrastructure discharge did not commence until September 24, 2013. MPMC chose to consider this a trial period to allow us to ensure that the system was working correctly. The discharge system operated only during day shift at the mine (06:00 to 17:00) and the flow of discharge did not exceed 2.4 m^3/h (Hazeltine Creek average flows during this time were approximately 36 m^3 /h), therefore analysis of the effects of the discharge on the water quality in Hazeltine Creek is difficult.

There are three sample locations for the discharge system; HD-1us is located in Hazeltine Creek approximately 150 meters upstream of the discharge; HD-1 is the discharge effluent water (mixture of East and West MTD), and W7 is located in Hazeltine Creek approximately 800 meters downstream of the discharge. In this report we have included the water quality results for Hazeltine Creek (W7) in section 5.1.12 and the results for HD-1 in section 5.1.6. No discussion is provided for HD-1us however the data is presented in Appendix D. Table 6.1 Hazeltine discharge results comparisons below highlights the results collected at all three sample locations.

An audit of the monitoring results and report for Hazeltine Creek was conducted by Minnow Environmental. The results of this audit are included in appendix G of this report.

Table 6.1 Hazeltine discharge results comparisons for permit required sampling dates

September 24 to October 29, 2013	Average				
	HD-1	HD-1us		W7	Target and Guidelines
Conductivity (in situ) µs/cm)	987.5	185.2		285.7	none
Conductivity (µs/cm)	1106.67	208.67		309.17	none
Nitrate (N) (mg/L)	1.52	0.0787		0.0403	3.0*
pH (pH)	8.02	8.01		8.19	6.5 - 9.5
pH (in situ) (pH)	7.92	8.04		8.10	6.5 - 9.5
Sulphate (mg/L)	458.67	33.13		35.35	309.00
Temp (in situ) (Degrees Celcius	6.65	4.73		4.04	see provincial guidelines
Total Cadmium (mg/L)	<MDL	<MDL		<MDL	0.000025 **
Total Copper (mg/L)	0.00244	0.00274		0.00147	0.007*
Total Molybdenum (mg/L)	0.1977	0.00206		0.00323	0.05*
Total Selenium (mg/L)	0.0050	<MDL		<MDL	0.002*
TSS (mg/L) ****	6.63	<MDL		35.33	***

Permit Target (Table 1)
* 30-day Mean
** Annual Mean
*** Change from background of 8 mg/L
**** TSS where less than MDL, MDL is used to calculate mean

It is important to note that the TSS result above MDL at HD-1 is unexpected. Monitoring results of the individual toe drains that feed the system do not exceed the MDL in 2013. This result may have been due to sampling error or some type of contamination to the system though metals results do not indicate this is an issue. Prior to discharge in 2014 MPMC will flush the system completely and run a complete analysis on the discharge water. Also of concern was the elevated TSS result for W7 on October 29, 2013. (See section 5.1.12 for more details).

7. BIOLOGICAL MONITORING AND LAKE SAMPLING

Biological monitoring and lake sampling is conducted in accordance with sub-section 3.2 of Permit 11678. The approved monitoring plan is provided in Appendix H of this report.

7.1. Biological Monitoring

7.1.1. *Selenium Monitoring*

In accordance with recommendations provided in previous selenium monitoring reports (Minnow, 2011; Minnow 2012), in 2013, MPMC retained Minnow Environmental Ltd. to continue selenium monitoring at selected locations in order to characterize current conditions (2013), assure the availability of an adequate quantity of pre-discharge selenium data for future receiving environments, document spatial and temporal differences, and examine apparent enrichment and trophic transfer relationships.

Sediment samples were collected in Hazeltine Creek by Minnow and the MPMC Environment Department on May 11, 2013. Rainbow trout muscle and ovary tissue were collected in Hazeltine Creek by Cariboo Environmental Quality Consulting and the MPMC Environment Department on May 17, 2013. Periphyton samples were collected at two sites in Hazeltine Creek by the MPMC Environment Department on August 26, 2013. Lastly, samples of sediment, periphyton, and benthic invertebrates were collected from erosional and depositional habitats of Hazeltine and reference creeks between October 7th to 9th, 2013 by Minnow, with sorting of depositional benthic invertebrate samples and sample submission by the MPMC Environment Department. The report presenting and interpreting the results is presented in Appendix I. The report concluded:

> "*Monitoring of selenium concentrations in sediment, periphyton, and benthos has indicated greater concentrations in Hazeltine Creek relative to reference areas. Sediment selenium concentrations were greater in 2013 than in previous years, but there was no evidence of an influence of effluent discharge (effluent was discharged to Hazeltine Creek between September 20th and October 31st, 2013). Conversely, selenium concentrations in periphyton, erosional benthos, and fish muscle were lower than those previously measured. Selenium concentrations in rainbow trout ovaries have not changed over time, and there appears to be no current risk of adverse effects, as the observed concentrations were well below the 20mg/kg dry weight effect threshold.*"

Recommendations based on the results are:

- *Continue to monitor water quality in accordance with the existing water quality monitoring* *program and evaluate potential changes over time on at least an annual basis.*

- *Continue annual monitoring of sediment at depositional habitats and of periphyton and benthos at erosional habitats, both upstream and downstream of the effluent discharge to Hazeltine Creek. These are relatively easy to monitor and have been recommended as key selenium exposure assessment endpoints (e.g., Young et al.2010; Hodson et al. 2010). Compare concentrations to those of previous years on an annual basis.*
- *Repeat the collection of rainbow trout ovaries (in the spring at Upper Hazeltine Creek at an initial frequency of annually) to determine selenium concentrations relative to previous observations and effect thresholds. Power analysis using rainbow trout ovary selenium concentrations in Hazeltine Creek from 2009-2013 indicated that a sample size of eight is sufficient to detect a significant change of ≤40% under all comparisons, as well as to detect a significantly different future mean that is well below the effect threshold of 20 mg/kg dry weight (Appendix Table B.8). As such, a sample size of eight is recommended for the repeat collection. In addition, the condition of all collected ovaries should be as consistent as possible to minimize variability (i.e.,ensure that all collected ovaries are fully developed and unspent). Compare concentrations of selenium in rainbow trout ovaries to those of previous years on an annual basis.*
- *Continue to report and record enrichment factors and trophic transfer factors.*
- *Review the selenium monitoring program annually, compare post-discharge to pre-discharge selenium concentrations, and adjust the monitoring program in response to findings*.

7.1.2.***Wildlife Observations***

The Mount Polley site and surrounding area is home to a wide variety of wildlife including ungulates, carnivores, raptors, water fowl, song birds, and mustelids. To meet requests by MOE and various stakeholders, to provide valuable data for evaluating the effects of the mine on wildlife, and to monitor wildlife habitat creation through reclamation, the MPMC Environmental Department records wildlife observations and incidents on the mine site. When possible, other departments on site track observations and submit them to the Environmental Department. This is valuable information for future reclamation and land use planning.

In 2013 there were 143 wildlife observations, including scat and tracks, reported at MPMC (refer to Table 7.1). Note that groups of animals reported in Table 7.1 (such as schools of fish or flocks of ducks) are documented as a single observation. Bird species observed include bald eagles, red tailed hawks, grouse, barn swallows, kill deer, and snow owls. Insects include wasps, bees, lady bugs and butterflies. The number reported observations is only a fraction of the actual observations, but documents the species present and suggests regular use of the site by wildlife.

Table 7.1 2013 wildlife observations at Mount Polley Mine

	On Site		Surrounding Area	
Animal	Number of Observations	Tracks/Scat Observations	Number of Observations	Tracks/Scat Observations
Ducks	10	-	4	-
Birds	12	-	1	-
Black bear	27	-	10	1
Deer	4	-	2	-
Moose	2	-	7	1
Wolf	-	-	-	1
Bobcat	-	-	-	2
Lynx	2	2	2	-
Coyote	2	-	-	-
Rabbits	1	-	-	1
Mice	1	-	-	-
Otter		-	-	1
Tadpoles	3	-	-	-
Toads/frogs	5	-	3	-
Rainbow trout/Fish	3	-	16	-
Benthic organisms	1	-	8	-
Insects	3	-	5	-

7.1.2.1. **Wildlife Incidents**

On April 4, 2013 a black bear was observed walking on the ice of the TSF. The bear fell through the ice and swam towards the South Embankment. Unable to climb out, the bear drowned. The body was later removed from the TSF and buried.

On June 24, 2013, a 2 year old black bear was hit and killed by a haul truck.

With extensive wildlife activity on the mine site, MPMC provides training to all employees regarding management of food waste, and bear awareness. This training and information helps keeps MPMC employees and the wildlife safe.

7.2. Lake Sampling

7.2.1. *Lake Sampling Locations*

In Polley Lake, station P1 is located near the Northwest end of the lake while station P2 is near the Southeast end. In Bootjack Lake, station B1 is located at the Northwest end of the lake and station B2 is located at the Southeast end. These stations are shown in Figure 1.3.

7.2.2. *In Situ Data*

Profiles of pH, conductivity, dissolved oxygen, and temperature were measured at P1 and P2 on Polley Lake and B1 and B2 on Bootjack Lake during spring overturn in May, and in August in 2013. In previous years, profiles were completed in winter (under ice), during spring overturn, and during fall overturn. This change was to allow MPMC staff to avoid the risks of winter lake sampling, and to monitor changes in lake conditions during algal blooms in the summer months.

At each station clarity of the water is measured using a standard secchi disk twice per month between spring and fall overturn. Appendix J includes tables of all in situ data for Polley Lake and Bootjack Lake. Results are provided in tabular form, and are graphed to provide a comparison to data collected in previous years.

7.2.2.1. **Polley Lake**

Profile results recorded at both P1 and P2 during spring overturn showed slightly elevated conductivity, average pH, and below average temperature and dissolved oxygen. The temperature and dissolved oxygen results may be related to the fact that the profiles were completed earlier in May than majority of the past years. Only temperature and dissolved oxygen summer data is available at P2 for comparison. Temperature results were typical for both stations. Dissolved oxygen at PI was above average at the surface and below average at depth, and dissolved oxygen at P2 was below average at the surface. At P1, elevated pH and conductivity was observed.

Secchi depth was recorded five times at P1 and six times at P2 in 2013. Due to staffing constraints and two disks lost during sampling, bi-monthly permit requirements were not met. The water clarity was lower than past years in the spring and summer, due to the occurrence of an algae bloom. This is likely related to the increase in phosphorus levels in Polley Lake, which is discussed in section 7.2.3.1.

7.2.2.2. **Bootjack Lake**

During spring overturn, at B1 and B2 the conductivity was elevated, while pH and dissolved oxygen remained consistent with previous years. The temperature profiles indicate that the lake was not isothermal at the time of sampling. No summer data is available from previous years for comparison; however sharp decreases in pH, temperature and dissolved oxygen were observed at approximately seven metres.

Secchi depth was recorded five times at B1 and six times at B2 in 2013. Due to staffing constraints and two disks lost during sampling, bi-monthly permit requirements were not met. The water clarity was similar to past years in all months, except June, when the water was less clear than normal. This indicates that the low clarity of the water in 2012 is not an ongoing concern.

7.2.3. *Lake Water Chemistry*

7.2.3.1. Polley Lake

Water chemistry sampling was completed at lake surface and at two metres above lake bottom during spring overturn and in August (with additional depths, 6m and 18m) sampled in non-isothermal conditions. Appendix J contains Polley Lake water chemistry data tables from 2001 to 2013 and graphs for data from 2008 to 2013.

Ammonia, Nitrate, and Phosphorus levels recorded in August 2013 at location P2-B indicated an increase in concentrations, however selenium concentrations have decreased.

In 2013 MPMC contracted Minnow Environmental to further investigation the elevated phosphorus levels in Polley Lake and the relationship of these levels to the algal bloom that has occurred over the past two summers on Polley Lake. The findings of this investigation are provided in Appendix K of this report.

In support of ongoing monitoring of the algal bloom and changes in Polley Lake, surface water samples were analyzed for chlorophyll a in July and August. Table 7.2 presents the results of this analysis.

Table 7.2 Chlorophyll a analysis results for Polley Lake 2013.

	Sample Location	
Date	P1-S	P2-S
3-Jul-13	0.763 ug/L	1.03 ug/L
8-Aug-13	14.1 ug/L	12.2ug/L

7.2.3.2. Bootjack Lake

Water chemistry sampling was completed at lake surface and at two metres above lake bottom during spring overturn and in August (with additional depth of 8m sampled in non-isothermal conditions). Appendix J contains water chemistry data tables from 2001 to 2013 and graphs for Bootjack Lake from 2008 to 2013. There have been no significant changes in water chemistry in Bootjack Lake; however, certain parameters have increased (if only very slightly in some cases), and should be closely monitored in the future. These parameters include chloride, nitrate, and sulphate.

In support of ongoing monitoring of the algal bloom and changes in Polley Lake, surface water samples in Bootjack Lake were analyzed for chlorophyll a in August. The measure at B1-S was 0.291 ug/L and B2-S was 0.456 ug/L.

8. DUSTFALL MONITORING

In 2011 MPMC established 5 dustfall monitoring stations around the perimeter of the site (Figure 1.3) to monitor dust in the environment. In 2013 an additional location was established on the East Shore of Polley Lake. The dustfall containers are collected every 28 to 32 days and sent to ALS for analysis of total, fixed, and volatile dust. There were no exceedences on the provincial guidelines in 2013.

9. CLIMATOLOGY AND HYDROLOGY

9.1. Meteorology

Mount Polley's Permit 11678 requires the collection of detailed meteorology data. The main objective of this data collection program is to provide site-specific precipitation and evaporation data for use in water balance calculations and hydrological predictions. In 2012, Mount Polley's automated weather station was replaced with two automated HOBO weather stations. These stations monitor temperature, rainfall, solar radiation, relative humidity, wind direction, wind speed, and wind gust speed. Weather Station #1 is located beside the tree plots reclamation research project and was installed in September 2012. Weather Station #2 is located at the TSF (between the Rock Quarry and Biosolids Storage Facility) and was installed in November 2012. Due to equipment and battery issues, only partial data is available from Station #1 for November and December, and no data is available from Station #2 for April through August and November.

Evaporation was previously based on measurements taken from an evaporation pan and an adjacent manual rain gauge; however, the new weather stations provide sufficient parameters to calculate evaporation with the Penman-Monteith Method using the WaSIM software developed by Cranfield University. The evaporation pan was decommissioned, as it no longer functioned accurately. Snowfall measurements are based on monthly snowpack testing done at multiple locations across the site.

9.1.1. *Wind Monitoring*

Figure 9.1 shows a wind rose developed from wind data collected by Weather Stations #1 and #2 from November 2012 to December 2013. The most dominant wind direction is SW; however there is some variation.

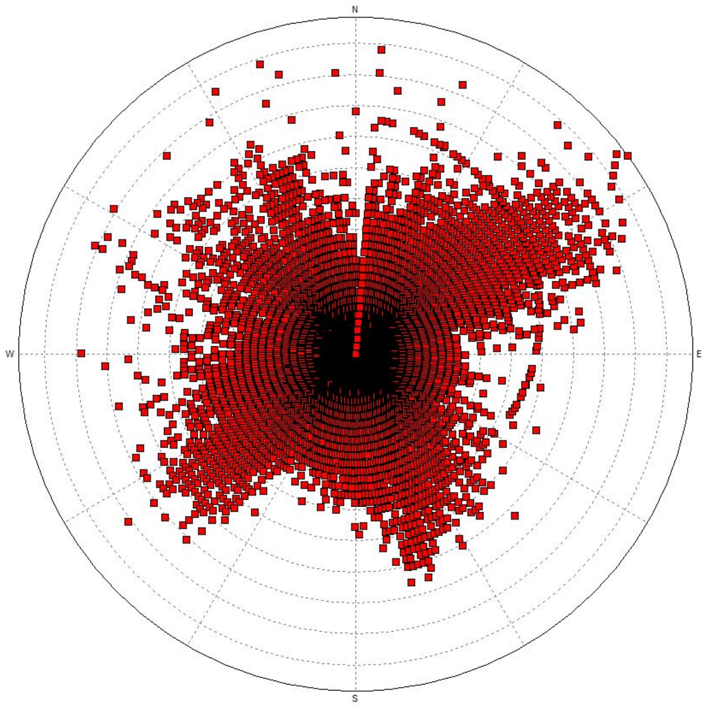

Figure 9.1 Windrose based on data from Weather Stations #1 and #2 (November 2012 – December 2013)

9.1.2. ***Temperature***

In 2013, the lowest monthly mean temperature was -7.4 °C recorded in December, and the highest monthly mean temperature was 16.8 °C recorded in August. Temperatures were warmer than average in all months except April, November, and December, which were cooler than average, and June, which was average. Figure 9.2 presents a comparison of 2013 maximum, mean, and minimum monthly temperatures with average monthly temperature data (based on data collected at Mount Polley since 1997). This data is shown in tabular form in Table 9.1.

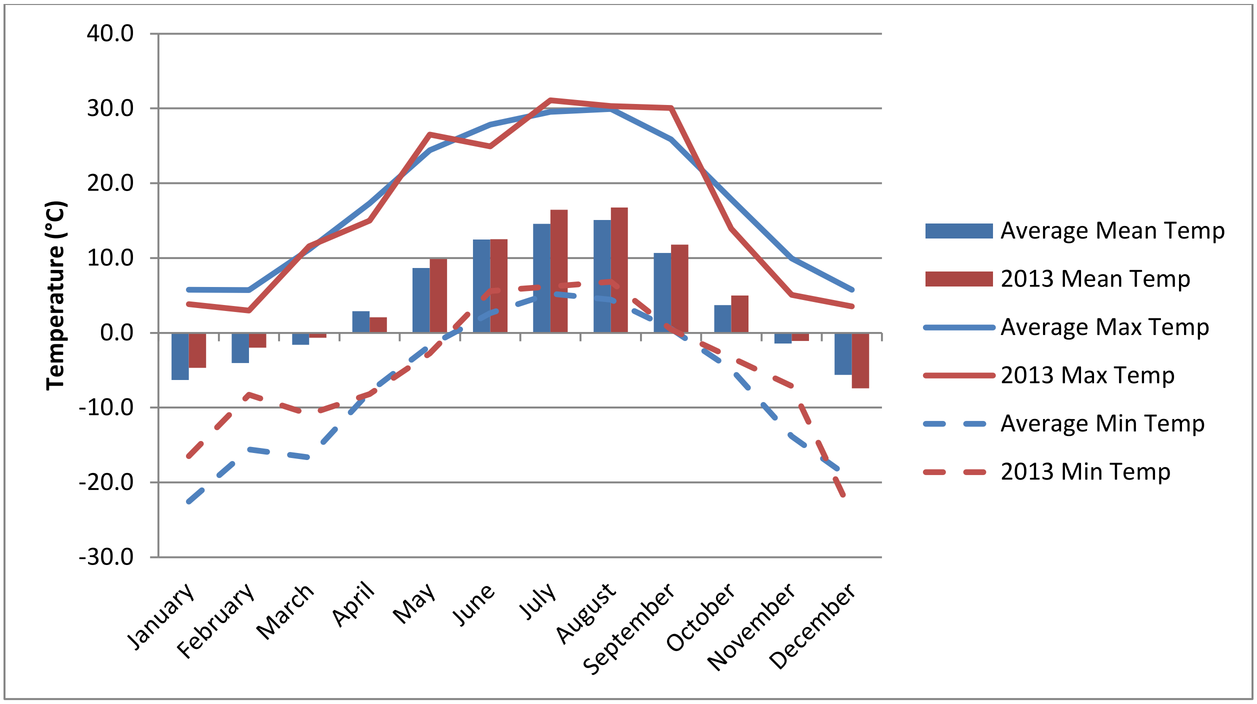

Figure 9.2 Maximum, mean and minimum monthly temperature data for Mount Polley (2013 vs. average)

Table 9.1 Mount Polley 2013 monthly precipitation, evaporation and temperature data

Month	Monthly Precipitation as Rain (mm)	Monthly Snowpack (mm Snow Water Equivalent)	Evaporation (mm)	Average Temperature (°C)	Maximum Temperature (°C)	Minimum Temperature (°C)
January	0.0	139	0	-4.7	3.8	-16.5
February	20.2	123	0	-2.0	3.0	-8.3
March	21.8	248	0	-0.7	11.6	-10.9
April	76.0	0	0	2.1	15.0	-8.2
May	67.0	0	119	9.9	26.5	-2.8
June	95.8	0	134	12.5	24.9	5.6
July	2.8	0	184	16.5	31.1	6.2
August	29.4	0	137	16.8	30.3	6.8
September	50.5	0	68	11.8	30.0	0.5
October	31.1	0	28	5.0	13.9	-3.3
November	2.3	40	2	-1.1	5.1	-7.1
December	12.5	112	4	-7.4	3.5	-24.2

9.1.3. ***Precipitation***

705 mm of precipitation was recorded in 2013, 409 mm as rain and 296 mm as snow water equivalent

(SWE). The 2013 snowpack went from approximately average in January, to below average in February, to 56 mm SWE above average at 248 mm SWE at the end of March (based on data from 1998 to 2013). Snowfall in November reached unprecedented levels and the snowpack at the end of December (144 mm SWE) was above average (108 mm SWE). Total rainfall was approximately average, and Mount Polley received the most rain in June, with 96 mm recorded. The driest non-freezing month was July, with 2.8 mm of rain recorded. In 2012, August and September were exceptionally dry, while April and June were much wetter than average. Monthly precipitation data are presented in Table 9.1 and Figure 9.3, with averages based on site data from 1996 – 2013.

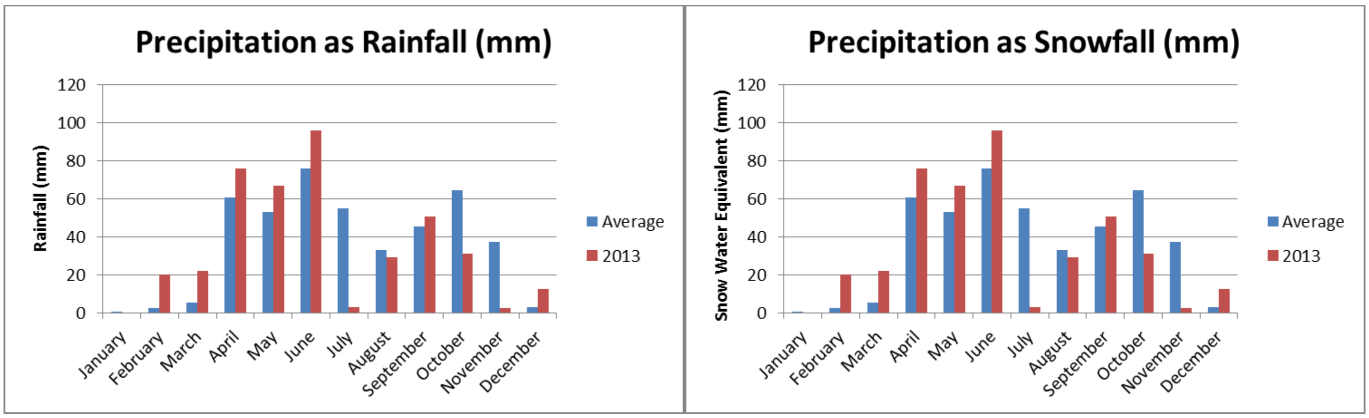

Figure 9.3 Monthly precipitation at Mount Polley (2013 vs. average)

9.1.4.*Evaporation*

Total evaporation for May to October 2012 (non-freezing period) amounted to 676 mm. July experienced the greatest amount of evaporation at 183.7 mm. Monthly evaporation data are presented in Table 9.1. Figure 9.4 below presents monthly comparisons of precipitation and evaporation for 2012.

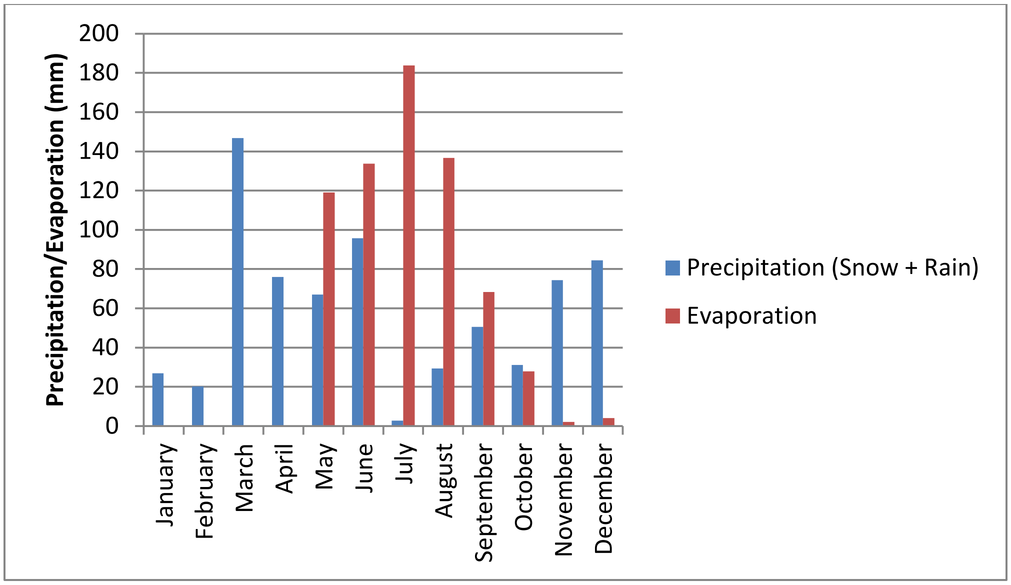

Figure 9.4 Total 2013 monthly precipitation and evaporation

9.2. Surface Flow Monitoring

In 2013, hydrological monitoring was completed at sites W1b (Morehead Creek), W4 (North Dump Creek), W5 (Bootjack Creek), W7 (Hazeltine Creek), and W12 (6km Creek) as required by Permit 11678. Supplemental monitoring was carried out at W8 (Northeast Edney Creek Tributary) and W10 (Edney Creek near its confluence with Hazeltine Creek at the Ditch Road bridge crossing), LD (the Long Ditch and SERDS Ditch), the NW Ditch, Joe's Creek Pipe, and the Main, Perimeter and, South Toe Drains at the TSF. Refer to Figure 1.3 for a map of monitoring locations.

The program included calibration (benchmarking) of staff gauges after freshet (completed in-house by MPMC Environmental Technicians and Surveyors), recording of staff gauge measurements during non-freezing months, and a structured flow monitoring program using the FlowTracker (a handheld Acoustic Doppler Velocimeter). Flow measurements were taken from April through October, typically bi-weekly, when flow rates were sufficient.

From discharge and staff gauge data collected, discharge rating curves were generated for the sites. This allows estimation of creek discharge at various stages, when field measurements are not available. The curves are based on the equation $Q = C(H-A)^n$, where **Q** is discharge, **C** is a multiplier that is a function of channel width (generally approximately two times channel width), **H** is stage, **A** is the point of zero flow, and **n** is a dimensionless number between 1.8 and 2.8.

Pressure transducers were installed at W1b, W5, W7, W10, and W12 during non-freezing months. These transducers continuously monitor pressure, allowing the creation of pressure-stage rating curves. Stage values estimated from pressure readings using the stage-pressure rating curve equation can then be substituted into the rating curve equation for discharge estimates. This results in an estimation of a creek's stage and discharge throughout the monitoring season.

Tables and figures presenting 2013 hydrology results at all sites, including hydrographs, rating curves, and pressure transducer figures, are presented in Appendix L.

9.2.1. *Site W1b – Upper Morehead Creek*

The benchmarking survey completed on June 13th indicated that the staff gauge had moved 9 mm; however the survey error was 4 mm, so the staff gauge was not adjusted. 11 staff gauge readings and 11 flow measurements were taken between May 16th and September 18th. The highest measured discharge rate was 0.561 m^3/s on April 30th. The stage-discharge rating curve equation based on 2012 and 2013 data was calculated to be $Q=1.7(H-0.035)^{2.8}$.

Pressure transducer data was recorded from April 16th to September 9th. A stage-pressure rating curve and equation were developed from monitoring results. Continuous records of stage and discharge values for the monitoring season were then estimated from pressure transducer data. The highest estimated discharge rate was 0.5021m^3/s on April 19th.

9.2.2. *Site W4 – North Dump Creek*

The benchmarking survey completed on June 13th indicated that the staff gauge had moved down 2 mm since 2011; however, the survey error was 2 mm, so the staff gauge was not adjusted.14 staff gauge readings were taken at W4 from May 10th to October 29th. A V-notch weir was installed in June 2012, and the stage-discharge rating curve equation based on weir specifications is $Q=(0.571.4)*(H-0.279)^{2.5}$.Using this formula, the highest measured discharge rates were 0.00622 m^3/s on April 9th and 0.00711 m^3/s on May 9th, which indicates a double peak in the hydrograph.

9.2.3. *Site W5 – Bootjack Creek above Hazeltine Creek*

The benchmark survey conducted on June 13th indicated that the staff gauge had moved 1 mm since 2011; however, the survey error was 1 mm, so the staff gauge was not adjusted. 24 staff gauge readings were recorded between March 10th and October 29th; however, due to low flow rates, only 7 flow measurements were taken between April 20th and June 25th. The highest measured discharge rate was 0.0181 m^3/s on April 20th, although it appears the peak of the hydrograph was missed. The stage-discharge rating curve equation based on 2011, 2012, and 2013 data was calculated to be Q=2.9(H-

$0.11)^{2.4}$.

Pressure transducer data was recorded from April 20th to July 10th, when the water level dropped below the transducer. A stage-pressure rating curve and equation were developed from monitoring results. Continuous records of stage and discharge values for the monitoring season were then estimated from pressure transducer data. The highest estimated discharge rate was 0.184596 m^3/s on April 20th, although it is possible the peak of the hydrograph occurred prior to transducer installation.

9.2.4. *Site W7 – Upper Hazeltine Creek*

The benchmarking survey completed on June 13th confirmed that the staff gauge has not moved since 2010, when the new staff gauge fixture was installed. 28 staff gauge readings and 14 discharge measurements were recorded in 2012 between April 12th and October 31st. The highest measured discharge rate was 1.0220 m^3/s on April 22nd. The stage-discharge rating curve equation based on 2011, 2012, and 2013 data was calculated to be $Q=10.5(H-0.13)^{2.4}$.

Pressure transducer data was recorded from April 12th to September 23rd, with additional monitoring carried out through November 11th as part of the discharge system. A stage-pressure rating curve and equation were developed from monitoring results. Continuous records of stage and discharge values for the monitoring season were then estimated from pressure transducer data. The highest estimated discharge rate was 1.918 m^3/s on April 19th.

9.2.5. *Site W10 – Edney Creek*

A benchmark survey conducted on May 30th indicated that the benchmarks may be shifting. A new benchmark was established, and the staff gauge was not adjusted; however the 2012 and 2013 curves are consistent. 8 staff gauge readings were taken between may 8th and November 12, but only 3 discharge measurements were recorded between July 10th and September 10th. Dangerously high flows did not permit early season monitoring. The highest measured discharge rate was 0.0209 m^3/s on June 27, although the hydrograph clearly peaked much earlier in the season.

Pressure transducer data was recorded from May 8th to August 14th. A stage-pressure rating curve and equation were developed from monitoring results. Continuous records of for the monitoring season were then estimated from pressure transducer data. Flow relationships were not developed due to a lack of data to use in curve development, but based on stage data the hydrograph peaked prior to May 8th and on June 20th.

9.2.6. ***Site W12 – 6 km Creek at Bootjack Road***

The benchmark survey conducted on June 13th indicated the staff gauge has not moved. 12 staff gauge readings and 10 flow measurements were taken between April 16th and September 18th. The highest measured discharge rate was 0.327 m^3/s on April 30th. The stage-discharge rating curve equation based on 2012 and 2013 data was calculated to be $Q=3.7(H-0.53)^{2.3}$.

Pressure transducer data was recorded from April 16th to September 25th. A stage-pressure rating curve and equation were developed from monitoring results. Continuous records of stage and discharge values for the monitoring season were then estimated from pressure transducer data. The highest estimated discharge rate based on pressure transducer data was 0.8524 m^3/s on April 19th.

9.2.7. ***Supplemental Sites***

Flow monitoring was also done at supplemental sites, including W8 (Northeast Edney Creek Tributary), Joe's Creek Pipe, the NW Ditch, the SERDS Ditch and Long Ditch combined, and the Perimeter, Main, and South Toe Drains. Results are presented Appendix L. Fluctuations in Long Ditch discharge rates occur depending on whether water is being pumped into it from the Wight Pit. These flow measurements are primarily used for maintaining the site water balance.

9.3. Groundwater Static Water Levels

Graphs comparing the static water level (SWL) results for site groundwater wells in 2013 with historic levels are presented in Appendix M.

95R-5: The SWL fluctuated between 0.0 m and 2.0 m from 1997 until 2008, when levels dropped to 4.5 m, and have since remained between 3.5 m and 5.0 m.

GW96-1a/b: In 2013, SWLs at these sites remained consistent with previous years.

GW96-2a/b: In 2013, SWLs at these sites remained consistent with previous years.

GW96-3a/b: In 2013, SWLs at these sites remained consistent with previous years.

GW96-4a/b: In 2013, SWLs at these sites remained consistent with previous years.

GW96-5a/b: In GW96-5a, SWLs typically fluctuate between 0.0 m and 2.0 m. After dropping to below 4.0 m in 2012, water levels returned to normal levels in 2013. In GW95-5b, seasonal fluctuations are observed. Levels have been slightly lower in recent years due to interception of runoff water upstream of the TSF.

GW96-7: From 1996 through 2008 the SWL fluctuated between 2.0 m and 4.0 m. In 2008, levels rose to ground level (0.1 m above ground in the PVC pipe casing), then dropped to a low of 8.1 m in October 2011. Levels have since fluctuated between 5.0 m and 7.0 m.

GW00-1a/b: SWLS in these wells have historically mirrored each other, fluctuating annually and seasonally between 0.5 m and 3.0 m. Since 2007, levels have remained above 1.5 m, and in 2012 and 2013 have stabilized between approximately 1.0 m and 1.3 m.

GW00-2a/b: SWLs in these wells have historically mirrored each other and shown seasonal fluctuations. In 2013, SWLs at these sites remained consistent with previous years.

GW00-3a/b: Prior to 2006, the SWLs in GW00-3a and GW00-3b typically fluctuated between 4.0 m and 6.0 m. Since 2006, SWLs in both wells have mirrored each other, showing seasonal fluctuations between 3.0 and 5.0 m.

GW11-1a/b: In 2011 and 2012 the SWL in GW11-1a was at ground level. In 2013 it dropped to approximately 1.1 m. The SWL in GW11-1b increased from 3.6 m in 2011 to approximately 3.0 m in 2012 and 3.2 m in 2013.

GW11-2a/b: SWLs in these wells mirror each other and show seasonal fluctuations. In 2013, SWLs at these sites remained consistent with previous years.

GW12 Series: Note that figures for the GW12 series wells are not included in Appendix M, as only two data points have been collected.

9.4. <u>Water Balance</u>

Table 9.2 provides the mine site and TSF water balance summary for the period October 1, 2012 to September 30, 2013. The model is presented over this period (the hydrological year) to avoid complications due to water storage in snow.

The Springer Pit, Cariboo Pit, and Wight Pit continued to collect water from groundwater infiltration, precipitation, and runoff collection, while losing water to evaporation, dust control, and site sprinklers, with a net accumulation of 217,168 m^3. The Northwest Sump collected runoff from the Northwest Ditch below the Temporary PAG Stockpile, and the West Ditch Sump (constructed in June 2013) collected water from upper Mine Drainage Creek, for a total of 100,365 m^3. 317,539 m^3 of these volumes was used in the mill for processing (ultimately ending up in the TSF), resulting in a net dewatering of the Cariboo Pit of 58,139 $m^{3.}$

While 12,313,803 m^3 of supernatant was recycled to the mill for processing, a total of 317,539 m^3 of process water from the pits contributed to the TSF storage volume increase. Other inputs included 4,467,719 m^3 from precipitation and runoff both directly into the TSF, and indirectly via the seepage collection ponds, the Long Ditch, the SERDS Ditch, and the Mill Site Ditch and Sump system (which also accepts domestic wastewater from the Mill and Exploration sites). An additional 208,433 m^3 from the Wight Pit underground operation dewatering system were pumped into the TSF via the Long Ditch. 2,155,366 m^3 of water was “removed” from the system when it was entrained in the pore spaces of the tailings, and 803,165 m^3 were returned to the environment through evaporation from the TSF and seepage collection ponds. 70, 080 m^3 of unrecoverable seepage was lost from the system, and 208 m^3 was also returned to the environment via the Hazeltine Creek discharge system.

These volumes equate to a gain of 1,964,872 m^3 of water in the TSF over this period, however; calibration of the model with a bathymetric survey on August 22, 2013 indicates that the actual volume increase was 1,709,093 m^3. The volume of the TSF supernatant at the end of this period was 6,179,216 m^3, and the elevation of the water surface was 963.35 masl. An additional 825,349 m^3 of water was stored in the Cariboo Pit at the end of this period, for a total of 7,004,565 m^3 of water stored on site. The detailed site water management schematic, water balance framework, and calculations are provided in Appendix N.

Table 9.2 Mount Polley water balance summary (October 2012 – September 2013)

Component (Inputs/Outputs)	Pits		TSF	
	To/From Environment	Other	To/From Environment	Other
Precipitation	362,755		2,162,416	
Evapotranspiration (including sprinklers and dust control)	-1,015,690		-803,165	
Runoff (Ditch) Collection	100,365		2,297,851	
Process Water		-317,539		317,539
Pit Water		-58,139		208,433
Groundwater (infiltration/seepage)	870,103		-70,080	
Groundwater (for domestic/mill use)			7,452	
Discharge			-208	
Entrained in Tailings				-2,155,366
TOTAL	317,533	-375,678	3,594,266	-1,629,394

Notes:

1. Process water is net accumulation in TSF (balance of reclaim line outputs and slurry inputs)

9.4.1.*Water Management Strategy*

Since mining commenced at Mount Polley, the area of disturbance has expanded over time and the site has transitioned from having a water deficit (pumping water out of Polley Lake) to having a water surplus.

9.4.1.1. Short-term Water Management Strategy

Given that approximately 7,000,000 m^3 of water was stored on site in the Cariboo Pit and TSF at the end of 2013, the fact that after 2014 the Cariboo Pit will no longer be able for water storage, and the geotechnical constraints of TSF, MPMC has developed a Short-term Water Management Strategy with the goal of reducing the existing water surplus on site over the next three to five years.

MPMC is in the process of applying for a permit to discharge approximately 3,000,000 m3 per year of treated water into Polley Lake to reduce TSF geotechnical requirements and return water to local watersheds. MPMC is looking to move forward with the permit application for implementation and startup in 2014. The proposed design parameters are an annual discharge of 3,000,000 m^3 over twelve months into Polley Lake (at the old water intake pipe location) with treated water meeting the BCWQG for aquatic life. Activities carried out as of December 31, 2013 are:

- **October 24, 2013:** MPMC notified MOE of intent to apply for an amendment to Permit 11678.
- **October 24, 2013:** MPMC started discussions through Implementation Committee meeting with First Nations around Water Management Strategies (also met November 28th, January 23rd, and March 12th).

- **November 6, 2013:** Consultation with Public Liaison Committee Meeting.
- **November 18, 2013:** Official conversation held with MOE to start application process.
- **December 4, 2013:** Environmental Protection Notice posted and published.

During this, research and planning will be carried out towards implementing the long-term water management strategy.

9.4.1.2. Long-term Water Management Strategy

Due to mine-influenced water collection systems, the site has a projected annual water surplus of 1,500,000 m^3 of water. Currently Permit 11678 allows 1,400,000 m^3 to be discharged into Hazeltine Creek; however, currently this cannot be achieved due to a lack of flow in the permitted water source (dam-filtered water), and to a lesser extent water quality constraints. With the goal of having a neutral site water balance, additional water sources will be identified and continued research, including further development of the site passive treatment system, will be carried out to work towards improving the quality of potential discharge water sources. A report completed by SRK Consulting Inc. (Appendix O) which is discussed in section 10.3.3 provides further background information on long-term water quality and water quantity projections.

10. MINING PROGRAM

10.1. Surface Development to Date

At the end of 2013, the total disturbed area at the Mount Polley Mine site was 1085.83 ha. Areas of the various disturbed and reclaimed units are outlined in Table 10.1, and Figure 10.1 depicts areas disturbed in 2013 and reclamation sites (displayed on the August 2013 aerial orthophoto mosaic).

The total disturbed area of the mine increased by 56.09 ha in 2013; however, revisions to the disturbed areas map show an 84.56 ha increase compared to 2013 (due to certain mine components being less accurately delineated in the 2012 map). Waste dump expansions included 10.90 ha of the Temporary PAG Stockpile, and a 27.39 ha increase of the SERDS. The Springer Pit expanded, and now encompasses the Cariboo Pit and a portion of the North Bell Dump, but no undisturbed ground was impacted. In 2013, the 6.69 ha West Ditch was constructed between the mine site and Bootjack Lake. At the TSF, expansion between 4 Corner and 5 Corner caused 4.74 ha of disturbance and expansion at the Perimeter Embankment caused 2.51 ha of disturbance. Installation of the Hazeltine Creek discharge system pipe grade and new tailings line pipe grade disturbed an additional 1.21 ha and 2.65 ha, respectively. Table 10.2 provides a breakdown of disturbed areas by mine component.

Concurrently with surface development, progressive reclamation is ongoing. Table 10.1 provides the areas re-sloped, seeded, fertilized, and re-vegetated in 2013, and total reclamation to date. A detailed discussion of site reclamation is provided in section 11.

Table 10.1 Summary of areas disturbed and reclaimed to December 31, 2013

DISTURBANCE	MINING		RECLAMATION								
	AREA DISTURBED (ha)		AREA RECONTOURED (ha)		AREA SEEDED/PLANTED (ha)		AREA FERTILIZED (ha)		AREA REVEGETATED * (ha)		LAND USE ** OBJECTIVE
	2013	TOTAL ***	2013	TOTAL ***	2013	TOTAL ***	2013	TOTAL ***	2013	TOTAL ***	
WASTE DUMPS	38.29	291.75	0.00	55.44	1.81	29.42	2.34	26.64	0.00	10.74	1. Wilfdlife Habitat 2. Recreation/Hunting/Grazing
TAILINGS PONDS	11.11	356.87	0.00	23.95	0.00	14.75	0.00	12.00	0.00	0.00	1. Wilfdlife Habitat 2. Recreation/Hunting/Grazing
PLANT SITE	0.00	35.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Wildlife Habitat (consider maintaining mill building as an industrial complex)
ROADS	0.00	151.55	3.34	3.34	0.00	0.00	0.00	0.00	0.00	0.00	Area Access or reclaim to surrounding land use
PIT AREAS	0.00	164.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Physical stability and safety Reclamin accessible portions as wildlife habitat
STOCKPILES	0.00	38.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1. Wilfdlife Habitat 2. Recreation/Hunting/Grazing
LINEAR (pipelines, powerlines, etc.)	6.69	21.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Ditches: Riparian Wildlife Hatbitat Hydroline: Maintain or reclaim to surrouding land use
OTHER	0.00	21.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1. Wilfdlife Habitat 2. Recreation/Hunting/Grazing
EXPLORATION****	0.00	4.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1. Wilfdlife Habitat 2. Recreation/Hunting/Grazing
TOTAL	**56.09**	**1086.47**	**3.34**	**82.73**	**1.81**	**44.17**	**2.34**	**38.64**	**0.00**	**10.74**	-

EXEMPT (high pit walls)	115.157	ha

* To be recorded as "revegetated" it must have supported vegetation that will lead to the designated land use objective for at least one year

** Specify land use. Options include: forestry, grazing, wildlife habitat, recreation, agricultural, industrial, residential and other.

*** Total up to December 31, 2013

**** Includes exploration geology base only.

Table 10.2 Mount Polley Mine disturbed areas – breakdown by mine component

Major Sections	Disturbed Area	End of 2012 Area (ha)	2013 Area (ha)	2012 Disturbed Areas (ha)*	Reclaimed Area (ha)	Comments	Permitted Projected Disturbed Area (ha)
Rock Disposal Sites	Boundary Dump	3.72	3.72	SERDS: 27.39 ha Temporary PAG Dump: 10.90 ha	0.00	Not Active	3.72
Note: Since the slopes will be re-sloped to 2:1 or better, the area of the 2:1 slope is included, rather than the repose area that exists on unreclaimed slopes.	East RDS (including leach pad and tree plots)	50.62	50.63		2.31		50.63
	Highway to Heaven	13.17	13.13		0.00		13.13
	North Bell Dump (NBD)	63.51	59.34		22.73		59.34
	NEZ Dump	21.81	21.81		5.13		21.81
	SERDS & Tailings Road	81.72	109.11		0.00	Active	112.42
	Temporary PAG Dump	23.11	34.01		0.00		48.71
	All Rock Disposal Sites Total	**257.66**	**291.75**	**38.29**	**30.17**		**309.76**
Pit Areas	Cariboo Pit	28.57	0.00	Springer Pit expansion within existing mine footprint.	-	Now Springer Pit	0.00
	Springer Pit	60.93	106.85		0.00	Active	106.85
	Wight Pit	34.81	35.24		0.00	Active	35.24
	Boundary Pit	11.43	11.58		0.00	(Underground)	11.58
	Rock Quarry	8.59	10.84		0.00	Not Active	10.84
	Pit Areas Total	**144.33**	**164.51**	**0.00**	**0.00**		**164.51**
Stockpiles	Tailings Soil	2.95	2.95	Changes due to expansion within the existing mine footprint and due to map revision.	0.00	Not Active	2.95
	Stockpile #1	15.61	9.98		0.00	Active	9.98
	NEZ Soil	9.29	9.29		0.00	Not Active	9.29
	Mount Polley Soil	3.94	3.94		0.00		3.94
	High Ox Stockpile	8.80	8.80		0.00	Active	8.80
	Biosolids	2.62	3.41		0.00		3.41
	New High Grade Ore Stockpile	0.00	0.00		-	Not Active	18.00
	Stockpiles Total	**43.21**	**38.37**	**0.00**	**0.00**		**56.37**
Roads	Boundary/Wight Pit Connector Road	2.38	2.38	Changes due to expansion within the existing mine footprint and due to map revision.	0.00	In use, but not under active construciton.	2.38
	Polley Lake Access Road	0.98	0.98		0.00		0.98
	Mill /TSF Connector Road	12.56	12.58		0.00		12.58
	New Access Road	27.92	27.90		0.00		27.92
	Old Tailings Haul Road	12.08	12.70		0.00		12.70
	Crusher Road	6.38	1.39		0.00		1.39
	Old Wraparound Road	13.47	13.47		0.00		13.47
	Wight Pit Haul Road	16.84	17.92		0.00		17.92
	Wight Pit/Tailings Road	15.87	18.51		0.00		18.51
	West Haul Road	30.17	32.97		2.85		32.97
	Ore Switchback Road	11.34	10.75		0.00		10.75
	Tailings Haul Road	-	-		-	Not Active	30.70
	Roads Total	**149.99**	**151.55**	**0.00**	**0.00**		**183.81**
Tailings Storage Facility	Corner 4 to Corner 5	16.27	16.99	Hazeltine Discharge Pipe Grade: 1.21 ha Tailings Pipe Grade: 2.65 ha Corner 4 to Corner 5: 4.74 ha Perimeter Embankment: 2.51 ha Note: Additional changes within footprint due to TSF surface expansion	0.00	Undergoing construction (non-freezing months)	19.95
	Main Embankment	7.52	7.32		0.00		7.32
	Perimeter Embankment and Pond	30.83	29.23		0.00		29.23
	South Embankment	7.80	7.50		0.00		7.50
	TSF South and Main Ponds	32.17	31.07		0.00		31.07
	Tailings Surface	207.83	213.32		0.00		213.32
	East Till Borrow	14.26	17.48		0.00		17.48
	South Till Borrow	26.27	26.27		14.75		26.27
	Hazeltine Discharge Pipe Grade	0.00	1.21		0.00		1.21
	Tailings Pipe Grade	0.00	2.65		0.00		2.65
	TSF - Southwest Pond	3.93	3.83		0.00		3.83
	Tailings Storage Facility Total	**346.88**	**356.87**	**11.11**	**14.75**		**359.83**
Miscellaneous - Linear	Long Ditch	7.35	7.35	West Ditch: 6.69 ha	0.00	Active	7.35
	Hydro Line	3.24	3.24		0.00		3.24
	SERDS Ditch	2.15	2.10		0.00		2.15
	West Ditch	0.00	6.69		0.00		6.69
	Northwest PAG Ditch	0.58	1.69		0.00		1.69
Miscellaneous - Other	Old Dispatch	3.54	19.33		0.00		19.33
	Orica Sites	1.95	1.95		0.00		1.95
	Helipad	0.69	0.69		0.00		0.69
Miscellaneous - Exploration	Geology Area	4.29	4.29		0.00		4.29
Miscellaneous - Plant Site	Mill Area	19.79	19.82		0.00	Property footprint set	19.82
	Warehouse Area	15.67	15.64		0.00		15.64
	Miscellaneous Total	**59.25**	**82.79**	**6.69**	**0.00**		**82.84**
	OVERALL TOTAL	**1,001.32**	**1,085.84**	**56.09**	**44.92**		**1,157.12**

Notes:
1) The difference between the 56.09 ha of calculated disturbance increase and the 84.56 ha total disturbance increase compared to 2012 is due to the revision map components.
2) In addition to map revisions, changes in the disturbed area associated with certain mine component were observed due to mine site expansion and continued operational changes.
2) Projected disturbance areas are based on permitted expansion. This, however, is expected to increase if the anticpated M-200 permit amendment application to extend the mine life is approved.

10.1. Projected Surface Development

Mining activities at Mount Polley will continue over the next five years largely according to the life-of mine plan which outlines approximately ten years of production. Total production rates over this period are projected to be on average between 90,000-100,000 tonnes per day. Milling rates are projected to remain constant at approximately 8,000,000 tonnes per annum.

Over the next five years, mining will occur in the Springer and Cariboo/C2 areas. In general, the mining sequence will be as follows: Springer Phase 3, Cariboo/C2, Springer Phase 4, and Springer Phase 5. A list outlining production areas by year is included below:

2014: Springer Phase 3, Cariboo/C2, and Springer Phase 4

2015: Cariboo/C2 and Springer Phase 4

2016: Cariboo/C2 and Springer Phase 4 and Springer Phase 5

2017: Springer Phase 4 and Springer Phase 5

2018: Springer Phase 5

Table 10.2 shows projected surface disturbance that is currently permitted; however, this number is expected to increase if the anticipated M-200 permit amendment application to extend the mine life is approved.

Underground mining is currently being performed in the Boundary Zone at Mount Polley, with the portal site located in the bottom of the previously mined Wight Pit. Underground mining is projected to continue at least into 2015 with a total of approximately 300,000 tonnes of total production. Scoping studies are currently being undertaken to determine the viability of extending this operation into the Martel Zone. Underground operations are not projected to create a material effect on surface disturbance or waste generation due to the relatively small size and location of the workings.

Material handling will largely follow existing practices over this period. Non-acid generating (NAG) waste will continue to be placed in the SERDS and utilized in TSF construction. Potentially acid generating waste will continue to be stockpiled in the NW PAG stockpile, before being rehandled into the pits at the end of the mine life. Refer to section 10.3.1.for a discussion of handling PAG material.

10.1. Stability of Works

10.1.1. *Rock Disposal Sites*

Examinations of RDSs are made in accordance with section 6.10.1 of the *Health, Safety and Reclamation Code for Mines in British Columbia*. Monitoring of RDSs occurs according to the terms and conditions of a variance granted by MEM on February 9, 2001. Monitoring occurs at the East RDS, the North RDS, NEZ Dump and the Cariboo Pit RDS.

10.1.2. *Tailings Storage Facility and Associated Works*

The TSF and associated works were inspected in 2013 by AMEC. The completed "2013 As-Built and Annual Review Report" will be provided to MEM under separate cover from this report.

10.2. Salvaging and Stockpiling of Surficial Materials

As required by the July 25, 2013 M-200 permit amendment; MPMC has developed a Soil Management Plan, which is included as Appendix P. To collect information for developing the Plan, and to guide future reclamation practices, a comprehensive quality assessment of site soil stockpiles was completed in September 2013. Results are appended to the Soil Management Plan. This Plan was reviewed by a third party consultant, Moss Giasson (Montane Environmental Services).

Table 9.3 provides an updated inventory of site soil stockpiles, and Figure 10.2 shows the stockpile locations. In 2013, approximately 75,800 m^3 of soil was salvaged from the mine site:

- 3,700 m^3 from the Temporary PAG Stockpile expansion was stockpiled below the PAG Dump.
- 3,200 m^3 of material from Springer Pit expansion was placed in the SEZ 2 stockpile.
- 15,600 m^3 was stripped for the new Cariboo Pit connector road and placed in the Ore Switchback stockpile.
- 32,000 m^3 of material was salvaged and stockpiled in front of the expanding SERDS.
- 13,800 m^3 of soil was stripped in for the new TSF Haul Road and stockpiled in windrows along the road, except for 3, 000 m^3, which was placed on the East RDS.
- 6,900 m^3 of material from TSF expansion was stockpiled along the Perimeter Embankment.

7,250 m^3 of overburden from the NBD Till Stockpile was used for progressive reclamation on the NBD (placed at a depth of 20 cm). In addition, the 42,500 m^3 of material in the Cariboo Pit stockpile was moved to a new stockpile (SEZ 1) to allow for expansion of the Cariboo Pit. 3,825 m^3 and 4,525 m^3 of material were placed (depth of 25 cm) below the Helipad, and above the Waste Haul Road (in the Pond Zone), respectively. This soil was from the old Cariboo Pit stockpile and from stripping for the expanding Springer Pit.

Seeding of new stockpiles for sediment and erosion control and prevention of invasive species establishment was planned, but not completed due to early snowfall. Seeding with a native grasses and forbes blend is scheduled for spring 2014. All new stockpiles are located away from natural waterways or drainage pathways.

Excluding areas that already have soil applied to them, the TSF supernatant surface, and the open pits (which will not be reclaimed), the total disturbed area of the mine is 653 ha. Based on the 1,303,390 m3 of soil currently stored on site, there is enough material to reclaim all disturbed areas using approximately 20 cm of soil to all disturbed areas. A conceptual plan for allocation of reclamation materials over the next five years is included in Table 10.3, which details the MPMC's five year progressive reclamation plan.

Table 10.3 MPMC soil stockpile inventory as of December 31, 2013

Stockpile Name	Location	Soil Volumes (m^3)	Year Established	Source of Stockpiled Soils	Stockpile Depth (m)
TSF Corner 1 - Windrow	TSF Corner 1	7,000	1995	New Corner 1 construction	1.5
Main Embankment- Stockpile	SE of Main Embankment	156,400	1995	ME OG/MESCP/Main Till Borrow/ME Basin Liner	3.0
Perimeter Pond - Stockpile/Windrow	Both sides of Perimeter Pond	9,800	1995/2013	Perimeter Embankment construction/expansion	2.0 - 3.0
Till Borrow - Stockpile/Windrow	North of (Perimeter) Till Borrow	25,000	1995	North American Laydown	1.5 - 2.0
Perimeter Embankment - Windrow	Edge of Perimeter Embankment	18,100	1995/2013	Perimeter Embankment expansion	1.5 - 2.0
South Till Borrow - Stockpile	Till Borrow Area 2	65,340	2000	ME Till Core Waste	1.0
Gavin Lake Road - Windrow	Gavin Lake Road (along South/Main Embankment)	24,200	1995	Bootjack - Morehead Connector	0.5
TRR - Windrow	Tailings Reclaim Road	44,900	1995	Tailings Reclaim Road	0.5
TSF Haul Road - Windrow	Adjacent to TSF Haul Road	3,000	2013		1.5
BJFSR - Windrow	Bootjack Forest Service Road (11.5 km - 12 km)	50	1995	Old Bootjack Forest Service Road (11.5 km - 12 km)	0.5
Mill Site - Stockpile	East of Mill/Admin Building (includes berms)	11,000	1995	Mill Site Area (concentrator & crusher)	2.0
Access Road km 12 - Stockpile	S-SW of Mount Polley Peak (by km 12 on Acces Rd)	209,000	1995	Cariboo Pit	2.5
Access Road km 13 - Stockpile	East RDS above Access Road	10,800	2013	TSF Haul Road	0.5
East RDS - Stockpile	Top of East RDS	92,000	2000	Additional Cariboo Pit Stripping	2.0
Highway to Heaven - Windrow & Stockpile	Highway to Heaven Access Road	52,000	2010		2.0
NEZ Dump	Top of NEZ Dump	6,500	Unknown	Unknown	2.0
Wight Pit Till - Stockpile	Bottom of Wight Pit Haul Rd	100,000	2005 - 2008	Wight Pit	1.5 - 2.0
Wrap Around Road - Windrow	Wight Pit - TSF Connector Road (below NEZ Dump)	101,600	2010	Moved from M1 Stockpile	2.0
North Bell Dump Till - Stockpile	North Bell Dump	185,300	2007 - 2012	Springer Pit	1.0 - 4.0
North Bell Dump Top - Stockpile	Top of North Bell Dump	8,500	2012	Southeast Zone	2.0
Springer North	Between North Bell Dump and Springer Pit	20,000	Unknown	Unknown	1.5
Ore Switchback	Below Cariboo Connector Road	20,600	2011/2013	Ore Switchback/Cariboo Connector construction	2.0
Northwest Sump Road - Windrow	Northwest Sump Road	7,500	2012	PAG Dump	2.0
PAG Dump - Windrow	Below PAG Dump	3,700	2014	PAG Dump Expansion	1.5
SEZ 1 - Stockpile	Top of Old Pond Zone Pit	50,000	2012/2013	Old Cariboo Pit Stockpile/Cariboo Pit expansion	10.0
SEZ 2 - Stockpile	Top of SERDS (near SEZ - 1)	7,000	2012/2013	Old Cariboo Pit Stockpile/Cariboo Pit expansion	2.0
SERDS - Stockpile	Below SERDS Dump	64,100	2012/2013	SERDS expansion	2.0
	Total Volume of Stockpiled Soils	**1,303,390**			

10.3. Waste Disposal and Acid Rock Drainage/Metal Leaching Program

The Acid Rock Drainage / Metal Leaching (ARD/ML) Monitoring Program for the Mount Polley Mine continued through 2013. The program characterizes all material types that will be handled during the mine life. Mount Polley's LECO analytical machine allows the mine to best manage mine waste by directing it to suitable storage sites, or to construction usage when required and if deemed suitable. The following sub-sections cover general discussions regarding the present program.

10.3.1. ***Waste Rock Characterization and Disposal***

Active monitoring of ARD/ML (Acid Rock Drainage/Metal Leaching) potential in the Mount Polley waste rock continued in 2013 as part of the established protocol which encompasses two stand-alone acid-base accounting (ABA) procedures: ARD analysis of diamond drillcore pulps to model a preliminary PAG body; and ongoing ABA determination of individual blasthole samples during mining operations to enhance the segregation of PAG from non-acid generating (NAG) waste. The program characterizes all material types that will be handled during the mine life. Analysis is completed on site by Mount Polley's LECO analytical machine, allowing the mine to best manage mine waste by directing it to suitable storage sites, or to construction usage when required and if deemed suitable.

Samples with a Neutralizing Potential Ratio (NPR) greater than 2 are considered NAG, and samples with NPR less than 2 are considered PAG. PAG is currently stored in the Temporary PAG Stockpile to the northwest of the Springer Pit, and will be relocated to the bottom of the Springer Pit and submerged upon mine closure. PAG has previously been transported to the bottom of the Wight Pit (to be submerged upon closure), and incorporated into the Low Sulphur Waste Dump.

On each bench, a sample of cuttings was collected from each blast hole and analyzed for total copper, non-sulphide copper, iron, and gold. Blasthole patterns were on average 7.4m burden by 8.5m spacing in the Springer Pit and 8.14m by 9.4m in the Cariboo Pit. Bench height is 12m in both Pits. Areas of ore and waste were identified by indicator kriging and assigning assay values, mill head value, etc. using an inverse distance calculation. The Mine Geologist then established ore/waste boundaries based on the calculated mill head values. For purposes of ARD-ML monitoring, ore areas were excluded from ABA analysis, as this material is run through the mill. Only samples in waste blocks are submitted for ABA. In areas of known NAG, the waste tonnage in each blast is divided by 40,000 in order to determine the number of ABA samples to be submitted (ie. 1 per 40,000 tonnes of waste). However, in areas of PAG, (or where NAG and PAG may coincide), the sample density is doubled to 1 per 20,000 tonnes. This helps to determine NAG/PAG boundaries, and provides a more robust dataset for the PAG. Survey data by pit is included in Appendix Q of this report.

A summary (by individual pit) of materials classified NAG and PAG, follows below in Table 10.4. Table 10.5 provides quantities of waste rock, tailings, and other mine waste added to site storage areas in 2013, and the total quantities on site as of December 31, 2013.

Table 10.4 Tonnes of waste taken from each pit in 2013 (summarized using truck count data).

Pit	NAG	PAG	Overburden (Till)	Total Waste + Overburden
Cariboo	11,681,864	2,411,030	425,635	14,518,529
Springer	5,605,778	923,119		6,528,897

Table 10.5 Quantities of waste rock, tailings, low grade ore, and other mine waste as of December 31, 2013

Name of Waste Pile or Pond	Acid Generating Waste (tonnes)		Potentially Acid Generating Waste (tonnes)		Non-Acid Generating Waste (tonnes)	
	2013	Total	2013	Total	2013	Total
Waste Dumps						
Main Zone (Bell Dump/Cariboo Area)	0	0	0	0	292,848	196,069,383
Boundary Dump	0	0	0	0	6,657	884,732
Waste Haul Road	0	0	0	0	74,739	10,708,204
TSF Haul Road	0	0	0	0	1,122,938	1,122,938
SE Zone/Pond Zone	0	0	0	0	12,175,156	31,175,156
Temporary PAG Stockpile	0	0	3,334,149	10,021,827	693,348	2,459,671
NEZ Dump/Wight Pit Dump	0	0	0	0	2064	36,002,064
Total			3,334,149	**10,021,827**	14,367,750	**278,422,148**
Tailings Pond						
TSF Construction Material	0	0	0	0	3,010,509	18,271,629
TSF Tailings	0	0	0	0	7,887,204	91,198,707
Total					10,897,713	**109,470,336**
Low Grade Ore/Coarse Reject/Other Mine Waste						
Low Sulphur Waste	0	0	0	0	135	752,433
Low Grade Stockpile	0	0	0	0	0	676,312
Total					25,265,463	**676,312**

10.3.1.1. Springer Pit

The majority of Springer Pit waste encountered in 2013 was NAG, except for some small isolated pockets of PAG on the west side of the pit. Springer NAG was hauled to the SERDS as well as to the new Tailings Haul Road, while PAG is stockpiled to the west of the Springer Pit in the Temporary PAG Stockpile.

10.3.1.2. Cariboo Pit

The majority of the Cariboo waste that was blasted in 2013 was NAG. The majority of the PAG is in a concentrated area in the south-west of the Cariboo pit. The east side of the pit is made up of waste that was placed there approximately seven years ago. Starting in October the mining of that filled area commenced. The backfill that is being re-mined in the east of the pit is mostly PAG. There are samples being taken at 50m intervals and being submitted for ABA analysis to confirm this. The Cariboo NAG waste was hauled to either to the SERDS, the TSF, or the new Tailings Haul Road. The PAG was dumped on the Temporary PAG Stockpile to the west of the Springer Pit.

10.3.1.3. Tailings Storage Facility

Total NAG Pit Material to the dam in 2013 was 3,010,509 tonnes.

10.3.1.4. ABA Data

There were 671 ABA samples analyzed in 2013. Approximately 13% of the waste mined was PAG. The results of these are summarized in Table 10.6 and are tabulated in Appendix Q.

Table 10.6 Summary of ABA data from the operating pits in 2013

Pit	Samples	Tonnes	S (%)	AP	C (%)	NP	NPR
Springer - NAG	227	3,716,875	0.42	5.80	0.32	25.95	6.98
Springer - PAG	74	621,759	0.81	23.39	0.31	25.93	1.13
Cariboo - NAG	309	9,107,296	1.33	3.85	0.21	15.94	9.75
Cariboo - PAG	61	1,319,686	1.19	20.86	0.19	16.04	0.59

10.3.1.5. Tailings

Representative composite tailings samples were collected and analyzed every month to represent the tonnage of tailings deposited to the TSF. Table 10.7 displays the ABA data for each of these samples. From January to December 2013, approximately 7,887,204 tonnes of tailings were deposited into the TSF. The composite tailings samples had an average NPR value of 11.46 and range NPR values from 3.48 to 19.5.

Table 10.7 ABA results from 2013 monthly tailings composite samples

Month	Tailings Composite NPR
January	10.52
February	19.31
March	13.44
April	12.8
May	14.1
June	8.84
July	12.54
August	19.5
September	8.03
October	7.42
November	3.48
December	7.53
2013 Average	11.46

10.3.1.6. Low Grade Stockpile

At 2013 year end, the low-grade non-economic ore was estimated to contain 676,312 tonnes of ore.

10.3.1.7. Rock Borrow Pit

No rock was extracted from the rock borrow in 2013.

10.3.1.8. Field Grab Samples

In 2013, 73 grab samples were collected for ABA analysis. Results for the LECO analysis for these are included in Appendix Q.

All samples collected from the temporary PAG stockpile were confirmed as PAG, all samples with the exception of one from the SERDS dump were confirmed as NAG.

10.3.2. *Drainage Water Quality Monitoring*

An important component in determining and monitoring long-term chemical stability of drainage from the pits and waste rock dumps is water quality monitoring. Locations monitored by MPMC (in addition to sampling required under the Permit 11678 (refer to the *2013 Annual Monitoring Plan* in Appendix C), sampling periods, and sampling frequencies are provided in Table 10.8. These water collection facilities and drainage monitoring locations are shown in Figures 1.2 and 1.3, respectively. Results are reported in Appendix R. Furthermore, in spring 2013 MPMC initiated a bi-annual seep survey program of all rock waste dumps on site, with representative seeps being monitored monthly. Collection of this data is used in long-term effluent water quality predictions and will continue through the next phase of mining.

Table 10.8 Mine site drainage water quality monitoring locations

Sample Location	Drainage Area	Sampling Period	Sampling Frequency
Cariboo Pit Sump (E8)		1997 – current	Bi-annually
Wight Pit (E10)		2006 – current	Bi-annually
Pond Zone Pit Sump (E12)		2010 – 2012	Bi-annually
Springer Pit (E11)		2011 – current	Bi-annually
Boundary Pit		2012 – current	Bi-annually
Joe's Creek Pipe	NBD seep	2010 – current	Monthly
Long Ditch	East RDS, NEZ Dump, SERDS, Wight Pit dewatering	2008 – current	Monthly
SERDS Ditch	SERDS, West Ditch, MDC Sump	2012 – current	Monthly
West Ditch	Springer Pit dewatering, west side of mine site	2013 - current	Monthly
NW Ditch Sump (E13)	Temporary PAG Stockpile	2012 – current	Monthly
West Ditch Sump (E14)	Upper Mine Drainage Creek, Springer Pit dewatering, West Ditch	2013 – current	Monthly
Bootjack Creek Culvert Sump	TSF Haul Road, Upper Bootjack Creek	2013 – current	Monthly
TSF Supernatant	Tailings slurry, seepage collection ponds	1997 – current	Quarterly
MESCP	MTD, STD, Main Embankment foundation drains	2001 – current	Monthly
PESCP	Long Ditch, SERDS Ditch, PTD	2001 – current	Monthly
Main Toe Drains (MTD)	TSF Main Embankment toe drains	1998 – current	Quarterly
Perimeter Toe Drain (PTD)	TSF Perimeter Embankment toe drain	2009 – current	Quarterly
South Toe Drain (STD)	TSF South Embankment toe drain	2011 – current	Quarterly

10.3.3. ***Long-Term Predictions – Kinetic Testing***

Kinetic rate information is a critical part of drainage chemistry prediction that provides a measure of the dynamic performance or "reactivity" of the material being tested. Stephen Day, MSc, PGeo, of SRK Inc. has been retained by MPMC to interpret results of the kinetic-testing program and recommend additional testing, if required. The most updated report was submitted as an appendix of the *2012 Annual Environmental and Reclamation Report.* The results from humidity cell testing were:

- Neutral pH weathering conditions are consistent with the carbonate content of the rock.
- A site specific criterion for PAG rock of 1.4 was suggested based on results from HC15.
- Time frames to generate ARD are in the order of decades, but shorter in the Springer Zone and the Southeast Zone where total inorganic carbon is lower.
- Relatively low contaminant leaching rates, with only molybdenum and selenium leaching at neutral pH.
- Release rates correlate with bulk characteristics for molybdenum.
- No parameters showed correlations with sulphur content.
- All tests (except one from the Pond Zone) are showing stable leachate chemistry and, based on current release rates, are not expected to show major changes on leachate pH in the short-term.

This information was combined with drainage water quality and site water balance data in 2013 by SRK to create a site-wide water quality predictive model. Results are detailed in the report Mount Polley Water and Load Balance (Appendix O). This report provides a screening level assessment of TSF discharge volume requirements against discharge guidelines in permit 1168. Analysis included an annual water balance, a hydrologic analysis on the variability of flow within Hazeltine Creek, an assessment of water quality across the site, and an estimation of allowable discharge volumes, as well as treatment requirements. The following conclusions were made based on the analysis:

- With the expected increase in total min catchment area, the 1.4 Mm^3 will be exceeded on an average bases (1.7 Mm3 in an average precipitation year).
- The 35% maximum discharge criteria becomes limiting during a 1 in 5 dry year, or drier years.
- There are no “hot spot” loading sources that contribute a disproportionate amount of constituent loadings to the TSF.
- Increases in selenium, molybdenum, nitrate and sulphate have been trending up since the mine operation resumed in 2005. These increases are expected to continue until their solubility limits are reached or until the end of the milling and mining process.
- Some metals, including copper and uranium, show no change in concentrations in the TSF due to precipitation in the milling process. After closure of the mine, when the milling process is no longer operational, it is possible that the concentrations will increase in the TSF.
- In order to achieve the desired 1.4 Mm^3 of annual mine water discharge, treatment will be required to reduce the concentrations of selenium and molybdenum and likely for sulphate and nitrate depending on the water treatment capacity.

10.4. Underground Mining Program

The development of ramps and other underground facilities continues in the Boundary Zone. In 2013 we produced 1,500m of development drifts. A 200m-long Alimak raise is being driven, and will provide an emergency escape route as well as a primary fresh-air source for the mine. We expect to begin mining the 4 boundary stopes in early 2014 which will produce 300,000 tonnes (t) grading 1.26% copper, 0.85 g/t gold and 5.5 g/t silver.

10.5. Test Heap Leach

In 2006, Mount Polley applied for an amendment to the M-200 permit allowing them to build a Heap Leach Pad and Copper Recovery facility. The amendment was granted on March 29, 2007. The M-200 permit requires that all monitoring data from the facility be included in this report.

In 2013, the total volume retrieved from the leachate collections recycle system (LCRS) was 5000 litres. The recirculation pump was not operated in 2013 except to discharge leachate to the mill for neutralization and discharge to the tailings. The discharge to the mill in April was 3000m^3. There was one minor spills of 80 L to the ground discharge of leachate..

The heap leach was decommissioned on September 26, 2012 owing to cold winter temperatures that could freeze piping and valves. Table 10.9 reports the sump levels in 2013. The concentration of the leachate was 30 ppm copper and 115 ppm iron in March. As no circulation of leachate took place in 2013 the concentration of metals in the leachate would have remained the same.

Table 10.9 Leachate solution level

Month	Leachate Solution Sump Level (ft)
March	20
April	25
May	8
June	8
October	10

Survey monuments established at the leach pad to monitor any movement were surveyed three times in 2013.

11. RECLAMATION PROGRAM

The objectives of the reclamation program are outlined in section 1.3. To achieve these objectives, as outlined in the Reclamation and Closure Plan, MPMC has established on site projects to research soil amendments and application methods, re-vegetation, vegetation metal uptake, and passive water treatment. In 2010, larger scale progressive reclamation commenced on site, and these activities are treated as research projects which will guide future reclamation practices.

An update on 2013 reclamation activities and research projects is included in this section, as well as the site five year reclamation plan, and updated reclamation bond costing.

11.1. Reclamation Cost Update

A detailed reclamation cost update for the end of 2013 has been completed and submitted to MEM.

11.2. 2013 Reclamation Activities

11.2.1. *Interim Re-vegetation*

Disturbed areas are grass seeded on an ongoing basis to prevent erosion and invasive species establishment. Soil stockpiles and areas that will likely not be re-disturbed are generally seeded with a native seed mix (Table 11.1). Sites that may be re-disturbed (or where preventing establishment of native species is the primary goal) are seeded with an aggressive seed mix (Table 11.1). This mixture grows rapidly in the short term, but dies off allowing the ingress of native species from surrounding areas. Table 11.2 lists interim seeding completed in 2013 by MPMC Environmental Department staff and First Nations temporary employees. Greater success with seed establishment has been observed with fall seeding, thus fall seeding was planned for disturbed areas in 2013; however, less seeding was completed than planned due to early snowfall. Seeded areas are shown in Figure 10.1.

Table 11.1 Aggressive and native seed mixes for reclamation

Species	% by Weight	% by Seed Count
Aggressive Seed Mix		
Dahurian Wildrye	50	23.27
Slender Wheatgrass	30	23.5
Perennial Ryegrass	15	20.01
Timothy	5	33.22
Native Seed Mix		
Mountain Brome	20	8.61
Native Red Fescue	10	17.81
Rocky Mountain Fescue	15	28.94
Wheatgrass, Bluebunch	25	10.76
Blue Wildrye	25	3.34
Junegrass	3	17.81
Ticklegrass	1	11.87
Lupinus polyphyllus	0.97	0.07
Fireweed	0.03	0.81

Table 11.2 Interim seeding completed November 12 – 13, 2013

Location	Type of Seeding	Approx. Area (ha)	Approx kg of seed	Application Rate (kg/ha)	Seed Mix
Gavin's Ditch	Interim	2.4	40	16.7	Native seed mix (minus june grass and tickel grasses)
Old SEZ Ditch	Interim	0.6	10	16.7	Native seed mix (minus june grass and tickel grasses)
West Ditch (between sump and Booster Station)	Interim	4.1	40	9.8	Native seed mix (minus june grass and tickel grasses)
Above WHR	Reclamation	1.5	40	26.1	Native seed mix
TOTAL		8.6	130		

11.2.2. ***Progressive Reclamation***

Progressive reclamation completed to date is detailed in Table 11.3. These areas are shown in Figure 11.1.

Table 11.3 Progressive reclamation completed at Mount Polley Mine as of December 31, 2013

Area	Parcel	Re-contoured (ha)		Soil/Till Applied (ha)		Seeded (ha)		Fertilizer/Biosolids (ha)		Tree-Planted (ha)	
		2013	total	2013	total	2013	total	2013	total	2013	total
NEZ Dump	2a, 2b1, 2b2	0.00	5.13	0.00	5.13	0.00	5.13	0.00	5.13	0.00	5.13
	Beside 2a/2b	0.00	2.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NBD	Parcels 1 - 10	0.00	11.59	0.00	11.59	0.00	11.59	0.00	11.59	2.00	2.00
	South Triangle	0.00	1.30	0.00	1.30	0.00	1.30	0.00	1.30	1.30	1.30
	Phase 1	0.00	2.21	0.00	2.21	0.00	2.21	0.00	2.21	0.00	0.00
	Phase 2	0.00	2.87	0.00	2.87	0.00	2.87	0.00	2.87	0.00	0.00
	Metro Van Research	0.00	2.81	2.81	2.81	0.00	0.00	2.34	2.34	0.00	0.00
	Wrap Around Toe	0.00	2.20	0.00	2.20	0.00	2.20	0.00	0.00	0.00	0.00
	Beside Research	0.00	4.76	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00
	Beside Phase 2	0.00	4.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boundary Zone	Dump	0.00	3.72	0.00	1.70	0.00	0.00	0.00	0.00	0.00	0.00
East RDS	Above Access Road	0.00	9.10	2.16	2.16	0.00	0.00	0.00	0.00	0.00	0.00
	Tree Plots	0.00	2.31	0.00	2.31	0.00	2.31	0.00	1.20	0.00	2.31
Waste Haul Road	Above WHR	1.81	1.81	1.81	1.81	1.81	1.81	0.00	0.00	0.00	0.00
	Below Helipad	1.53	1.53	1.53	1.53	0.00	0.00	0.00	0.00	0.00	0.00
South Till Borrow		0.00	23.95	0.00	0.00	0.00	14.75	0.00	12.00	0.00	0.00
	TOTAL	3.34	82.73	10.31	39.62	1.81	44.17	2.34	38.64	3.30	10.74

11.2.2.1. Waste Dump Reclamation

On the East RDS, soil was stripped from construction of the new TSF Haul Road to 2.16 ha at a depth of 25 cm. This soil contained woody debris.

On the NBD:

- Deciduous tree and shrub planting was carried out on the 1.3 ha South Triangle and on “biodiversity islands” in Parcels 1 – 10.
- Till and biosolids were applied to 2.34 ha (with till applied to an additional 0.47 ha parcel for the control) as part of a joint research project with Metro Vancouver.
- Material stripped in the SEZ in August 2013 was spread on a 2.0 ha portion of the NBD, adjacent to the research parcels.

Refer to Appendix S for a detailed summary of 2011 – 2013 NBD reclamation.

Continued reclamation of these sites will continue as outlined in the Five Year Reclamation Plan detailed in Table 11.2

11.2.2.2. Watercourse Reclamation

No watercourse reclamation was conducted in 2013, aside from interim seeding along Gavin’s Ditch, the SEZ Ditch, and the West Ditch.

11.2.2.3. Pit Reclamation

No pit reclamation was conducted in 2013. The Bell Pit, Pond Zone Pit, and SEZ Pit have been back-filled by waste dumps and will not require reclamation.

11.2.2.4. **TSF Reclamation**

No reclamation was conducted at the TSF in 2013.

11.2.2.5. **Road Reclamation**

Overburden from the Cariboo Pit stockpile (now moved to the SEZ stockpile) and from Springer Pit expansion was applied at a depth of 25 cm to a 1.53 ha parcel below the Helipad, and 1.81 ha above the Waste Haul Road in the old Pond Zone. The Pond Zone parcel in was seeded with the MPMC Native Seed Mix in October on November 13, 2013. Continued reclamation of these sites will occur according to the Five Year Reclamation Plan in Table 11.2.

11.2.2.6. **Treatment of Structures and Equipment**

All site structures and equipment are currently in use, and none were salvaged or disposed of in 2013.

11.2.2.7. **Securing of Mine Openings**

No sealing or securing of openings was completed in 2013, as underground operations are currently active.

11.3. Invasive Plant Management

As part of MPMC's updated Five Year Reclamation and Closure Plan, a site Invasive Plant Management Plan has been developed (Appendix T). No invasive species management activities were carried out in 2013; however, as part of implementing the Invasive Plant Management Plan, a formal third party assessment of infestation on site and corresponding management recommendations is being considered for 2014.

11.4. 2013 Research Update

11.4.1. *Tree Plots*

The first trial focused on the reclamation of the tops and slopes of the East rock disposal site (RDS). In 1998, 25 plots, each 15 m^2, were established on the top of the East RDS to test the response of grasses and tree seedlings to various thicknesses of soils, the use of fertilizer and various concentrations of biosolids. In 1999, an additional 11 plots were added to the overall configuration, to repeat some of the prescriptions as well as test the use of tailings as an amendment to the growth medium. In 2000, a total of 12 plots were created on the re-sloped surface between the 1170 & 1150 platforms of the East RDS. These plots tested various soil thicknesses as well as the use of biosolids in a similar manner to the 1998/99 plots.

Every year between 1998 and 2001, then in 2006, 2007 and again in 2012, the trees in each plot were monitored for parameters including total height, leader height, diameter at breast height or base, and vigour. In each study year, this data was collated and presented in report which is written by Ron Meister, RPF (Forestmeister Services). The 2007 report was appended to the 2008 *Annual Environmental and Reclamation Report*, and the 2012 report has been included as Appendix U.

11.4.1.1. **Native Species Establishment**

In 2010, on 5.13 ha of the NEZ Dump, three treatment units with varying seed and soil amendment application rates were established and planted with a native grasses and forbes seed blend. Native trees (lodgepole pine and Douglas-fir, paper birch, trembling aspen, and black cottonwood) and shrubs (Sitka alder, saskatoon, wood rose, and local live staked willows) were planted on these parcels in 2012. In 2013, a formal assessment of re-vegetative success was completed by Moss Giasson (Montane Environmental Services). His report is not yet complete, but will be available as Appendix V after June 2014.

In conjunction with this NEZ Dump trial, nine individual native species trial plots were established on each treatment unit. These plots were monitored for re-vegetative success in June 2011 and July 2012 (results were appended to the 2012 Annual Environmental and Reclamation Report, which also included formal survival studies conducted for the planted conifers and informal assessments for the planted deciduous tree and shrub species).

Progressive reclamation ongoing on the NBD using native species was not assessed for establishment success in 2013; however 2012 findings are presented as part of Appendix S.

11.4.1.1. **Biosolids**

In 1999, the MOE issued MPMC a permit to import biosolids from the Greater Vancouver Regional District (now Metro Vancouver) for the purpose of mine site reclamation (Permit 15968). After initial receipt and stockpiling of the biosolids shipments in 2000, the program was suspended; biosolids shipment recommenced in 2007. Stockpiled biosolids are stored in a permitted long-term storage site located near the Tailing Storage Facility.

Appendix V (available after June 2014) will provide an update on re-vegetative success of the NEZ Dump reclamation (established 2010); however; it is questionable whether the biosolids, which were applied at this site in 2008 were incorporated in a way such that nutrients are available to plants. Specifically, the biosolids may have been buried too deep for the vegetation to benefit from its application. 2012 results from using biosolids as a soil amendment in the tree plots (established 1998 – 2000) are presented in Appendix U.

In October 2013, MPMC continued with biosolids reclamation on the NBD that was initiated in 2011. As part of a MPMC – Metro Vancouver joint research project, 960 wet tonnes of Metro Vancouver Annacis Island Waste Water Treatment Plant Class A biosolids were applied to till on 2.334 ha (5 of 6 parcels) of a 2.81 ha area. This trial tested alternative biosolids application methods, and will explore reclamation prescriptions that promote primary succession of shrubs and trees, with this vegetation not being out-competed by dense grass growth (caused by the biosolids nutrient flush). Applications were completed in accordance with MOE permit 15968, and the overburden was sampled prior to mixing, as required under the permit (results in Appendix P). Refer to Appendix S for results of the 2012 assessment of NBD biosolids reclamation parcels and for the 2013 biosolids application Operational Report.

Table 11.4 summarizes Metro Vancouver biosolids deliveries and applications at Mount Polley from 2000 to 2013 (information provided by Metro Vancouver). All Metro Vancouver biosolids delivered to Mount Polley in 2013 met the requirements of Permit 15968, as well as the Organic Matter Recycling Regulation criteria for Class A Biosolids. Average 2013 analytical results of Annacis Island Waste Water Treatment Plant Class A biosolids are presented in Table 11.5. Results from a composite sample taken from the biosolids storage facility are provided in Table 11.6.

Table 11.4 Metro Vancouver biosolids deliveries and applications at Mount Polley (2000 – 2013)

Stockpile Location	Delivery Date	Biosolids Delivered			
		Annacis	Lulu	Total (wt)	Total (dt)
Tailings Storage Facility Stockpile (Area 1)	2000/01 inventory		10,754	10,754	2581
	Feb 7 - Nov 2, 2007		4,641	4,641	1114
	Aug 5 - Nov 1, 2009	7,101	124	7,225	2160
	Jan 1 - Nov. 12, 2010	16,136	42	16,178	4367
	Apr 4 - 14; July 4, 2011	1,206		1,206	338
	Apr 25 - Sept. 4, 2013	9,664		9,664	2706
NEZ	Sep 28 - Nov 19, 2008	3,875		3,875	1163
	Apr 15 - May 29, 2011	5,058		5,058	1416
North Bell	2012 deliveries: MPMC "Area 2" (May 30 - June 17)	1,060		1,060	297
	2012 deliveries: MPMC "Area 1" (June 18 - July 31)	1,482		1,482	415
	2013 Deliveries: Tree Trial Plots (Sept. 28 - Oct. 6)	960		960	269
	Delivered 2000-to-present	**46,541**	**15,561**	**62,102**	**16824**

	Site ID	ha	rate (dt/ha)	Biosolids Utilized			
				Annacis	Lulu	Total (wt)	Total (dt)
Applications	tree research plots (circa 2000/01)				234	234	56
	NEZ - **2008**			3,875		3,875	1,163
	North Bell Roadside Slopes (Areas 1 - 10) - **2011**	11.6	122	5,058		5,058	1,416
	North Bell (Areas 11 - 19) - **2012**	5.1	140	2,542		2,542	712
	North Bell Tree Trial Plots (Plots 2-6) - **2013**			960		960	269
						-	
	CONFIRMED - APPLIED/USED to date			**12,435**	**234**	**12,669**	**3,615**

Table 11.5 2013 average Metro Vancouver Annacis Island Waste Water Treatment Plant biosolids composition

METRO VANCOUVER'S BIOSOLIDS COMPOSITION

	BC Organic Matter Recycling Regulation		Annacis I. WWTP (Routine QC Station)			
			Numbers of Samples Collected	Dewatered Biosolids (Class A) Period: 15-Apr-13 - 15-Oct-13		
	Class A Biosolids	Class B Biosolids		Mean	Min	Max
Physical Parameters						
Total Solids (%)			32	26.5	23.4	30.3
Volatile Solids (%)			6	70.3	69.1	72.1
Electrical Conductivity (ds/m)			6	6.07	5.50	6.60
Bulk Density						
pH			6	8.1	7.8	8.4
Macronutrients (mg/kg dw)						
Total Kjeldahl Nitrogen (TKN)			6	52,633	49,400	55,300
Ammonia distillation			6	9,560	9,040	10,100
Nitrate/Nitrite-N			0	0.0	0.0	0.0
Nitrate/Nitrite-N (Available)			5	11.0	11.0	11.0
Phosphorus (Total)			31	24,568	22,600	29,200
Phosphorus (Available)			5	2,680	1,900	3,500
Potassium (Total)			20	1,730	1,550	2,050
Potassium (Available)			5	1,282	1,110	1,470
Calcium (Total)			27	23,756	21,900	25,500
Magnesium (Total)			27	6,132	5,460	6,990
Total Trace Elements (mg/kg)						
Aluminum			27	7,701	6,650	8,730
Arsenic	75	75	27	5.2	4.0	7.0
Barium			14	318	294	343
Cadmium	20	20	27	2.4	2.0	3.4
Chromium		1,060	27	64	42	99
Cobalt	150	150	27	4.3	3.7	4.9
Copper		2,200	27	894	759	1,030
Iron			27	33,137	28,500	37,600
Lead	500	500	27	56	36	71
Manganese			27	349	315	395
Mercury	5	15	27	1.8	1.0	3.2
Molybdenum	20	20	27	13.9	10.7	19.5
Nickel	180	180	27	26	18	38
Selenium	14	14	27	7.0	6.1	9.0
Silver			27	6.8	4.6	9.7
Zinc	1,850	1,850	27	1312	1090	1550
Bacteriology (MPN/g)						
Fecal Coliform - discrete	<1,000		79	125	19	820

Table 11.6 Results from biosolids storage facility composite sample taken December 18, 2013

Sample ID	**BIOSOLIDS COMPOSITE SAMPLE**
Date Sampled	18-DEC-13
Time Sampled	09:50
Matrix	Soil
Physical Tests	
Moisture	79.1
Leachable Anions & Nutrients	
Total Kjeldahl Nitrogen	5.15
Plant Available Nutrients	
Available Ammonium-N	7450
Available Nitrate-N	<6.0
Available Nitrite-N	2.4
Available Phosphate-P	1980
Available Sulfate-S	2070
Bacteriological Tests	
Coliform Bacteria - Fecal	16
Salmonella	Presumptive Positive
Salmonella Confirm	Not Isolated

11.4.1.2. <u>**Vegetation Metal Uptake**</u>

As part of the reclamation research program, vegetation is sampled and analyzed for metal content. The data from these studies is compared to relevant baseline data collected in 1989, 1995, and 1996. Since many of the sample sites used in the baseline studies have been disturbed, new permanent sites are currently being established which will be available for the rest of the mine life, and for post-closure monitoring. Along with comparisons to baseline data, studies at these sites will provide information metal uptake trends over time. No sampling was completed in 2013; however, a sampling program is planned for 2014 and the study design is included as Appendix W.

Metal content in soil was evaluated as part of the soil stockpile quality assessment completed in September 2013. Metal levels of the 23 soil stockpiles sampled are compared with available guidelines in Table 11.7. Guidelines were only exceeded for copper; however, baseline samples of soil test pits in 1995 had an average copper concentration of 350 ppm, indicating that soils in the area naturally have elevated copper levels.

Table 11.7 Comparison of 2013 soil stockpile sample results with soil guidelines for metal levels

Parameter	Canadian Soil Quality Guidelines	BC Contaminated Sites Regulation Guideline	Average Soil Stockpile Concentration (ppm)	Number of Sample Exceeding the Guideline
Copper	63		58.4	7
Zinc	200		5	0
Boron	2		0.2	0
Manganese		1800	55.8	0

11.4.1.3. Passive Treatment – Anaerobic Biological Reactor

The Anaerobic Biological Reactor (ABR) is a pilot passive water treatment system constructed at the Mount Polley site in 2009 in partnership with the Genome BC project. The objective of the ABR is to reduce elevated parameters in mine tailings effluent through microbial activity to concentrations appropriate for discharge into the natural environment. ABR water quality results continue to be monitored, and modifications to system design are ongoing based on research findings. Updated results are provided as Appendix X.

11.5. Five Year Reclamation Plan

11.5.1. *Progressive Reclamation*

Table 11.8 outlines Mount Polley's five year reclamation plan, and the reclamation sites are shown in Figure 11.2.

11.5.2. *Proposed Reclamation Research*

Ongoing monitoring will continue on all progressive reclamation and research projects, and the five year reclamation plan may evolve based on findings. Plans for additional research project are being developed to further guide progressive reclamation and promote the realization of MPMC's proposed end land uses. New proposed research projects include:

- Construction of a pilot-scale waste dump composed of intimately mixed NAG waste rock and tailings. Effects on runoff water quality will be monitored to assess the effectiveness of this method in reducing metal leaching due to waste rock exposure to oxygen and water. Project commencement is pending MEM approval.
- Development of a constructed wetland passive water treatment system at the ABR outflow in partnership with Thompson Rivers University. Construction is anticipated to take place in late 2014.

Ongoing monitoring will continue with all of the aforementioned research and progressive reclamation projects.

Table 11.8 Five year progressive reclamation plan

Site Specifications				Soil				Revegetation[1]			Schedule						
Site	**Parcel(s)**	**Area**	**End Land Use Objectives**	**Soil Stockpile Source**	**Volume (m^3)**	**Application Depth (cm)**	**Ammendments**	**Grass Seed Mix[3]**	**Shrub & Deciduous Tree Planting**	**Conifer Tree Planting**	**Re-Contour**	**Soil Application**	**Soil Ammendment Application**	**Coarse Woody Debris Applicaiton**	**Grass Seeding**	**Shrub & Deciduous Tree Planting**	**Conifer Planting**
North Bell Dump	Parcels 1-10	10.59	Wildlife, forestry	Wight Till	10,600	20	Biosolids (122 dt/ha)	Native grasses (35 kg/ha)	Black cottonwood - 60 sph Paper birch - 34 sph Trembling aspen - 34 sph Sitka alder - 172 sph Saskatoon - 34 sph Prickly rose - 34 sph Scoulers willow - 79 sph Juniper - 50 stem trial plot Soopolalie - 50 stem trial plot	Lodgepole pine - 1238 sph Douglas fir - 505 sph Western red cedar - 60 sph Sub-aplpine fir - 50 sph Hybrid spruce 65 sph Consider underplanting with later successional species in future.	2011	2011	2011	2011	2011	2013 - no survival 2014 - re-plant	2014
	South Triangle	1.30	Wildlife, forestrty	North Bell Dump Till	1,733	30	Fertilizer (75 kg/ha)	Native grasses (35 kg/ha)	2013 Black cottonwood - 1000 sph Sitka alder - 800 sph 2014 Juniper - 50 stem trial plot Soopolalie - 50 stem trial plot	Lodgepole pine - 1190 sph Douglas fir - 510 sph Consider underplanting with later successional species in future.	2011	2011	2011	-	2011/2012	2013	2014
	Phase 1	2.21	Wildlife, forestry	North Bell Dump Till	3,920	20	Biosolids (138 dt/ha)	Native grasses/forbes (35 kg/ha)		Lodgepole pine - 1190 sph Douglas fir - 510 sph Consider underplanting with later successional species in future.	2012	2012	2012	-	2012	2015	2015
	Phase 2	2.87	Wildlife, forestry	North Bell Dump Top	4,680	20	Biosolids (135 kg/ha)	Native grasses + lupine (35 kg/ha)		Lodgepole pine - 1190 sph Douglas fir - 510 sph Consider underplanting with later successional species in future.	2012	2012	2012	-	2012	2015	2015
	Metro Van Research	2.81	Wildlife, forestry	North Bell Dump Till	4,680	20	Biosolids (107 dt/ha) (on 2.34 ha)	1) No seed 2) Forbes mixture 3) Fireweed 4) No seed 5) Native grasses/forbes (10kg/ha) 6) Native grasses/forbes (5 hg/ha)	Black cottonwood - 200 sph Paper birch - 50 sph Trembling aspen - 50 sph Sitka alder - 200 sph Saskatoon - 50 sph Prickly rose - 50 sph Scoulers willow - 50 sph	Lodgepole pine - 1190 sph Douglas fir - 510 sph Consider underplanting with later successional species in future.	2012	2013	2013	-	2014	2014	2014
	Wrap Around Toe	2.20	Wildlife	North Bell Dump Till	14,418	6	None	Native grasses (~15 kg/ha)	Monitor natural vegetation ingress		-	2012	-	-	2012	TBD	TBD
	Beside Research	2.00	Wildlife, forestry	SEZ Stripping	4,000	20	None	If growth from seed in soil not sufficient: Native grasses/forbes (minus june grass and tickle grass) or forbes (application rate to be determined)		Lodgepole pine - 1190 sph Douglas fir - 510 sph Consider underplanting with later successional species in future.	2012	2013	-	Already in soil	2014	2015	2016
	Metro Van Research 2 (to be surved from Wrap Around)	2.00	Wildlife, forestry	North Bell Dump Till	4,000	20	Biosolids (107 dt/ha)	1) No seed 2) Forbes mixture 3) Fireweed 4) No seed 5) Native grasses/forbes (10kg/ha) 6) Native grasses/forbes (5 hg/ha)	Black cottonwood - 200 sph Paper birch - 50 sph Trembling aspen - 50 sph Sitka alder - 200 sph Saskatoon - 50 sph Prickly rose - 50 sph Scoulers willow - 50 sph	Lodgepole pine - 1190 sph Douglas fir - 510 sph Consider underplanting with later successional species in future.					2014	2015	2015
	Wrap Around	3.14	Wildlife, forestry	North Bell Dump Till	6,280	20	Biosolids[2]				2016	2016	2016	2016	2016	2017	2018
Waste Haul Road	Heli Pad Area	1.53	Wildlife, forestry	SEZ (old Cariboo)/Springer Pit	3,825	28	None	Native grasses/forbes (minus june grass and tickle grass)	-	Lodgepole Pine - 840 sph Douglas fir - 260 sph	-	2013	-	Already in soil	2014	-	2015
	Above WHR (Pond Zone)	1.81	Wildlife, forestry	SEZ (old Cariboo)/Springer Pit	5,456	30	None	Native grasses/forbes (22 kg/ha)	-	Lodgepole Pine - 840 sph Douglas fir - 260 sph	-	2013	-	Already in soil	2013	-	2015
East RDS	Highway to Heaven	9.02	Wildlife, forestry	Highway to Heaven	18,040	20	Biosolids[2]				2018	2018	2018	2018	2018	2019	2020
	Above Access Road	9.10	Wildlife, forestry	TSF Rd Stripping (2.16 ha) Expansion Stripping (6.94 ha)	18,200	20	None	If growth from seed in soil not sufficient: Native grasses/forbes or forbes (application rate to be determined)			2011	2013 - 2015	-	Already in soil	2014/2015	2015/2016	2016/2017
South Till Borrow	TRU Wetland	12.72	Wildlife, livestock	N/A				TRU constructed wetland revegetation plan pending			Additional contouring/wetland creation and revegetation to occur according to TRU project 2014 - 2015						
	Soil Stockpile/Old Borrow	31.70	Wildlife, livestock	South Till Borrow	65,340	20	Biosolids[2]				2018	-	2018	2018	2018	2019	2020
NEZ Dump	Parcel 2 (a/b)	5.13	Wildlife, forestry	Wight Till	20,000	40	2a: fertilizer (238 kg/ha) 2b1: biosolids 2b2: fertilizer (71 kg/ha), biosolids	Native grasses/forbes 2a: 45 kg/ha 2b: 34 kg/ha	Paper birch - 100 sph Trembling aspen - 100 sph Black cottonwood - 200 sph Sitka alder - 100 sph saskatoon - 100 sph wood rose - 100 sph Willow live stakes - 40 sph	Lodgepole pine - 1300 sph Douglas fir - 700 sph	2010	2010	2010	-	2011	2012	2012
	North Triangle	11.73	Wildlife, forestry	Wight Till PAG Dump Stripping	5,865 17,595	5 15	None	If growth from seed in soil not sufficient: Native grasses/forbes or forbes (application rate to be determined)			2014	2014	-	Already in soil	2015	2016	2017
Boundary Zone	Boundary Dump	4.26	Wildlife, livestock	PAG Dump Stripping	8,520	20	None	If growth from seed in soil not sufficient: Native grasses/forbes or forbes (application rate to be determined)			2011	2015	-	Already in soil	2015	2016	2017
	Below Access Road	3.10	Wildlife, forestry	PAG Dump Stripping	6,200	20	None	If growth from seed in soil not sufficient: Native grasses/forbes or forbes (application rate to be determined)			2015	2015	-	Already in soil	2015	2016	2017

Notes:

1) Blank cells indicate prescription to be determined based on findings from ongoing research and progressive reclamation.

2) Base biosolids application rates on lastest results from trials and progressive reclamation.

3) Native grasses/forbes: mountain brome, native red fescue, Rocky Mountain fescue, wheat grass - blue bunch, blue wild rye, june grass, tickle grass, fireweed.

Native grasses: mountain brome, native red fescue, Rocky Mountain fescue, wheat grass - blue bunch, blue wild rye.

Forbes: lupine, fireweed, yellow mountain-avens, wheat yarrow, pearly everlasting.